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Auditing Complex Estimates: Does Emphasizing Management Bias Decrease Sensitivity to Measurement Imprecision?

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Dedication

To my grandfather, J. Randolph Wilson, CPA

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Auditing Complex Estimates: Does Emphasizing Management Bias Decrease Sensitivity to Measurement Imprecision?

by

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Both management bias and measurement imprecision threaten the accurate reporting of complex accounting estimates. Actions by audit regulators and practitioners often place an imbalanced emphasis on the former. Although bias is an important concern, it is also necessary to consider how emphasizing risks arising from bias might impact auditors' sensitivity to risks stemming from measurement imprecision. In an experimental economics setting, I find that auditor-participants generally exert a high level of effort when the risk of management bias is high. However, when the risk of bias is relatively low but auditors still face residual risks from imprecision, emphasizing risks related to bias leads auditors to "lower their guard" to a greater extent than when both bias and imprecision are emphasized. Accordingly, this study suggests that efforts intended to direct auditors' attention towards management bias can come at the expense of auditor sensitivity to imprecision and result in insufficient audit effort when the risk of bias is low.

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CHAPTER I
Introduction

Auditors face significant challenges when evaluating complex accounting estimates (e.g., Griffith, Hammersley, and Kadous 2015a; Glover, Taylor, and Wu 2017). Prior research in accounting illuminates difficulties arising from technical aspects of auditing complex amounts and social challenges triggered by psychological mechanisms. This dissertation reviews and categorizes extant literature directed towards complex estimates, noting the importance of considering the implications of technical difficulties faced by auditors in light of social challenges. I also motivate and report the results of an experiment that investigates a potentially negative consequence of efforts by auditing regulators and practitioners to improve audit outcomes related to complex estimates by emphasizing risks arising from management bias.

Both the potential for management bias and the presence of measurement imprecision threaten the accurate reporting of estimates. Recent developments in professional standards, regulatory inspections, and practitioner methodologies have emphasized the importance of auditors' response to bias more than imprecision. Although mitigating management bias is critical for effective audits, this study examines the possibility that an imbalanced emphasis on risks related to bias could decrease auditors' sensitivity to difficulties associated with measurement imprecision when the risk of bias is low.

Management bias in complex estimates is an important concern for auditors. However, irrespective of whether an individual audit client poses a relatively high or low risk of bias, measurement imprecision presents an additional challenge that is pernicious in its own right. Christensen, Glover, and Wood (2012) and Cannon and Bedard (2016) provide evidence that the degree of uncertainty surrounding complex estimates frequently exceeds several multiples of audit materiality. Given the difficulties associated with estimating uncertain amounts (e.g., Bratten, Jennings, and Schwab 2016), audit failures related to complex estimates can arise even in the absence of intentional bias. Indeed, a sizable majority of U.S. public companies that issue restatements do so for reasons unrelated to intentional bias or fraud (Posen 2007; Hennes, Leone, and Miller 2008), and Fang, Huang, and Wang (2017) find that the rate of unintentional misreporting increases as underlying complexity increases.

Several factors present in the current audit environment elevate auditors' attention to management bias, but do not similarly emphasize that measurement imprecision could also contribute to the risk of an undesirable audit outcome. A prime example of this imbalanced emphasis is mandatory fraud brainstorming (AICPA 2002), which directs auditors to consider the engagement-specific risk of intentional bias without providing a similar platform to consider other sources of risk. Specifically related to estimates, auditing standards frequently require auditors to consider the impact of bias on complex estimates, without specifying equivalent mandates for considering the effects of measurement imprecision (AICPA 2002; PCAOB 2010a, b). Regulatory inspections and firm methodologies often place similar emphasis on the risk of bias in complex estimates (PCAOB 2016; CAQ 2017). Because auditors can readily observe characteristics that contribute to differences in the relative risk of bias among different audit-clients (e.g., the strength of internal controls or management integrity), it is important to consider whether emphasizing management bias can lead auditors to be insufficiently sensitive to measurement imprecision when the risk of bias is low. If so, *overall* audit quality could suffer.

I develop theory that suggests an imbalanced emphasis on bias is likely to cause auditors to view the relative risk of bias as a simple decision rule for exerting audit effort. My interactive hypothesis predicts that attuning heuristically to the risk of bias will lead auditors to reduce costly audit effort, when the risk of bias is low, by more than what would be warranted given continued risks from measurement imprecision. Such behavior is likely to reflect auditor decision processes that do not deliberatively, or systematically, incorporate the implications of measurement imprecision. By contrast, emphasizing the risk of bias *and* measurement imprecision is likely to mitigate insufficient audit effort when the risk of bias is low, and promote a more systematic decision-making approach whereby auditors more fully consider both sources of risk when approaching complex estimates.

To test this notion, I construct a contextually stark laboratory experiment, with undergraduate participants, that captures the monetary incentives and choices present in strategic interactions between auditors and reporters.[1] Within participants, I manipulate the risk of management bias as high or low by varying whether or not reporters benefit economically from intentionally inflating an accounting estimate. Between participants, I manipulate whether auditors view reminders in the experimental materials that emphasize (1) risk related to management bias, or (2) risks arising from bias *and* measurement imprecision. Auditors mitigate exposure to the negative consequences of an audit failure – whether driven by bias or solely by imprecision – by exerting costly audit effort. To cleanly test the joint effect of the relative risk of bias and emphasis, I hold the magnitude of measurement imprecision constant across conditions. Importantly, participants in *all* conditions understand the implications that both management bias and measurement imprecision have for auditors' and reporters' payoff functions. Thus, the bias-emphasis condition is akin to recent developments in the audit environment intended to heighten auditors' sensitivity to management bias, while the dual-emphasis condition captures a more balanced emphasis on both sources of risk.

[1] Throughout this paper, I use the terms *manager* and *reporter* interchangeably when referring to audit clients. Although auditors are typically thought of as interacting with client *management*, the term *reporter* connotes a more specific characterization of the client's role in the context of a strategic interaction with auditors.

Results show an interactive effect of the two manipulated factors on auditors' costly effort choices. When the estimate is likely to be biased, auditors exert a high level of effort regardless of whether the experimental materials emphasize management bias alone or both bias and imprecision. However, when the risk of bias is relatively low, auditors in the condition emphasizing only management bias reduce effort to a greater extent than auditors exposed to an emphasis on bias and imprecision. Lower effort in the bias-emphasis condition, when the risk of bias is low, results in a significantly less optimal allocation of audit resources.[2] This effect appears to be subconscious, as auditors *assess* similar overall risk levels across emphasis conditions, yet they make different effort decisions. Supplemental analysis supports the notion that, consistent with theory, an imbalanced emphasis on bias leads auditors to rely heuristically on the presence or absence of bias when choosing a level of costly audit effort. By contrast, a more balanced emphasis on both bias and imprecision results in a more systematic decision-making process.

Beyond auditors' decisions, the results from my experiment offer insight into reporter behavior surrounding complex accounting estimates. Predictably, reporters incentivized to be biased exhibit substantial bias. However, I find that even reporters with financial incentives to provide an unbiased estimate exhibit some degree of upward reporting bias that reflects their preference for more favorable realizations of the estimated amount. That is, akin to Hales' (2007) study involving investors' propensity to engage in "motivated reasoning," I find that reporters' preferences have a modest influence on their estimates, despite financial incentives to be

[2] As described in more detail below, optimal behavior is assessed in relation to auditors' payoff function as defined in my abstract game. While my setting does not incorporate participants in roles akin to investors or regulators, auditors' incentive function does capture the conventional demands of such stakeholders in a context analogous to auditing complex estimates. Namely, auditors generally expect, and are expected, to exert a high level of effort to obtain adequate assurance over estimates (e.g., Griffith et al. 2015a, Glover et al. 2017).

unbiased. From purely a financial reporting perspective, this result speaks to difficulties associated with preventing managers' unintentional biases from impacting their reporting of subjective amounts. From an auditing standpoint, this finding underscores the importance of mitigating the potential for under-auditing when the risk of bias appears to be relatively low.

Reflecting the reality that bias is an important concern, prior auditing research documents ways to improve auditors' response to bias in complex estimates (e.g., Griffith, Hammersley, Kadous, and Young 2015b; Rasso 2015). However, auditors are responsible for responding to risk from both intentional and unintentional sources. My study indicates that efforts by auditing standard setters, regulatory inspectors, and practitioners to increase auditor sensitivity to management bias in complex estimates can come at the expense of inadequate auditor attention to measurement imprecision. That a more balanced emphasis on bias *and* imprecision mitigates this deficiency in auditor judgment suggests a potential avenue for improving current auditing standards, the focus of inspections, and prescribed audit methodologies. As a practical example, my results suggest that overall audit quality would likely benefit from augmenting fraud brainstorming sessions with discussions regarding the risks posed by other significant sources of risk.

The remainder of this dissertation is organized as follows. Chapter II reviews, categorizes, and discusses prior literature related to auditing complex estimates. Chapter III provides institutional background, develops theory, and presents my study's hypothesis. Chapter IV describes my research method. Chapter V presents results, and Chapter VI concludes.

CHAPTER II
Technical and Social Challenges of Auditing Complex Accounting Estimates

Providing assurance over complex accounting estimates connotes both technical and social challenges for auditors. This chapter reviews prior research in an effort to more clearly differentiate between these two classifications of the potential drivers of deficient audit judgments. While auditing research has long specified a link between uncertainty and diminished audit quality, only recently have scholars begun to focus specifically on complex accounting estimates. One prominent set of studies specifically examines technical challenges incumbent to auditing complex estimates. Other researchers have devoted more attention towards social, or psychologically based, difficulties arising from estimates.

While both streams of research provide unique strengths and insights, understanding the distinctions between technical and social challenges is important because focusing on one or the other provides an incomplete picture of the difficulties surrounding audits of complex estimates. Insofar as deficiencies in audit judgements can be caused by both technical *and* social challenges, potential remedies suggested by research findings may be at least partially ineffective if they address only one class of difficulty, but not the other. To fully evaluate proposed solutions to the challenges of auditing complex estimates, it is important to consider both the technical and social implications of solutions.

This chapter contributes to the literature on complex accounting estimates by 1) explicitly distinguishing between technical and social, or psychologically based, challenges stemming from audits of complex estimates, and 2) suggesting a framework to facilitate more intentional consideration of the unique implications of the two classes of difficulty. Greater attention by regulators, practitioners, and scholars to the distinctions between technical and social difficulties can help identify policies, audit procedures, and avenues for future research that more completely address the challenges of providing assurance over complex accounting estimates.

Uncertainty and Audit Quality

Although not specifically focused on complex accounting estimates, a stream of literature published around the turn of the century speaks to the effect of uncertainty on audit outcomes.[3] Wright and Wright (1997) examine several factors that have potential to influence auditors' decisions to waive an audit adjustment. Utilizing data taken from the working papers of actual audit engagements, Wright and Wright (1997) regress whether or not a proposed audit adjustment is waived on the adjustment's materiality level, effect on income, client-specific factors, and, notably, subjectivity. Wright and Wright (1997) define subjectivity as uncertainty regarding either the appropriate accounting treatment, or uncertainty regarding the effect of an unknown future event on the accuracy of a reporting choice. Results indicate that auditors are significantly more likely to waive subjective adjustments. Braun (2001) conducts an experiment to corroborate and extend the themes illuminated by Wright and Wright (1997). She also finds that potential audit adjustments related to relatively subjective or uncertain amounts are less likely to be booked.

Libby and Kinney (2000) report results from two experiments suggesting that auditors are less likely to correct an overstatement if the adjustment would cause the company to miss forecasted earnings. In Experiment 1, the overstatement stems from the allowance for inventory obsolescence, an amount estimated by management. In Experiment 2, the overstatement results from an objectively observable inadvertent duplication of counts related to ending inventory.

[3] For this discussion, uncertainty can be loosely conceptualized as resulting from imperfect information about an accounting number. In the following chapter, I provide more precise definitions of related constructs as they pertain to the particular experiment reported in this dissertation.

Comparing the study's two experiments suggests that misstatements surrounding the more uncertain allowance account are less likely to be corrected than misstatements stemming from the more objectively measured inventory account.

Mayhew, Schatzberg, and Sevcik (2001) operationalize laboratory markets to directly examine the implications of accounting uncertainty for audit quality. In a setting where manager-participants make representations about the value of an asset, auditor-participants attest to managements' representations, and investor-participants bid for the asset, Mayhew et al. (2001) find that uncertainty increases auditors' propensity to agree with managements' assertions despite audit evidence to the contrary. Given the presence of negative financial consequences that arise when auditors develop reputations for impaired objectivity, this study speaks to the power of uncertainty in promoting acquiescence to client preferences.

Collectively, Wright and Wright (1997), Braun (2001), Libby and Kinney (2000), and Mayhew et al. (2001) provide an important backdrop for more recent research specifically focused on complex accounting estimates. These early studies document that the presence of uncertainty generally undermines audit quality by reducing the likelihood auditors require correction of misstated amounts. However, the above studies stop short of specifying a substantive theoretical basis for the effect of uncertainty other than to cite intuition that uncertainty reduces auditors' leverage when imposing an adjustment (e.g., Deis and Giroux 1992) or diminishes auditors' ability to agree on the appropriate accounting treatment (e.g., Magee and Tseng 1990).

The increased prominence of accounting estimates has spurred a growing interest in audit issues related to uncertain amounts. As a result, more recent studies build on this prior literature linking uncertainty to diminished audit quality by identifying specific difficulties made acute by uncertain accounting estimates. To date, scholars' efforts have generally been directed towards either technical or social challenges arising from audits of complex estimates.

Technical Challenges of Auditing Complex Estimates

Audit deficiencies identified in PCAOB inspection reports attest to the difficulty of providing assurance over complex estimates (e.g., PCAOB 2016). In an attempt to explain such challenges, Bratten et al. (2013) provide a thorough review of accounting literature relevant to auditors' approach to accounting estimates. Drawing on the theoretical research framework specified by Bonner (2008), Bratten et al. (2013) specify three categories of factors that affect the audit of estimates: environmental factors, task factors, and auditor-specific factors. Environmental factors include uncertainty, regulatory and legal considerations, and actions taken by the audit client or external valuation specialists. Task factors refer to the complexities and nuances of actually performing audit procedures over accounting estimates. Bratten et al. (2013) specifically highlight opportunities and incentives for management bias as a task factor contributing to difficulties underlying audits of estimates. Auditor-specific factors include auditor knowledge, expertise, and application of professional skepticism.[4] Bratten et al. (2013) note that these factors can interact within and between categories to impact auditor judgments, and offer suggestions for future research falling at the intersection multiple factors.

Broadly speaking, the factors identified by Bratten et al. (2013) represent difficulties stemming from technical aspects of auditing estimates. This theme is echoed by several other studies specifically addressing complex accounting estimates. Christensen et al. (2012) are

[4] While this category appears closest to what I describe as the social challenges of auditing complex estimates, deficiencies in auditor expertise or professional skepticism are not necessarily made manifest due to psychological mechanisms or biases. That is, one takeaway from Bratten et al. (2013) is that the complex and uncertain nature of auditing complex estimates is sufficient to expose inherent limitations in audit-specific factors even without psychological or social factors necessarily playing a role in deficient audit judgments.

among the first to attempt to quantify the magnitude of estimation uncertainty present in fair value estimates and the sensitivity of estimated amounts to changes in underlying assumptions. Christensen et al. (2012) use anecdotal, but representative, examples to demonstrate that very small changes (within a "reasonable range") to fair value inputs and assumptions often result in very large changes (up to 50 times larger than conventional audit materiality thresholds) to reported amounts.

Christensen et al. (2012) suggest that the demands of providing positive assurance over complex estimates are often likely to exceed the reasonable capabilities of audit professionals. As a result, the authors suggest that regulators could consider holding auditors to a different standard for amounts with extreme uncertainty. Additionally, Christensen et al. (2012) advocate for increased disclosures, and/or changes to the audit report, that would serve to provide financial statement users with more context regarding the magnitude of uncertainty surrounding estimates and limitations in auditors' ability to provide assurance over these amounts.

Cannon and Bedard (2017) utilize a questionnaire distributed to experienced audit personnel to corroborate the extreme magnitude of uncertainty surrounding complex estimates and provide further insights into the process and outcomes of auditing these amounts. Cannon and Bedard's (2017) respondents report that the range of estimates' uncertainty frequently exceeds specified materiality thresholds (72% of engagements, with 21% of engagements over five times materiality). Consistent with a strong link between uncertainty and technical difficulty, Cannon and Bedard's (2017) results suggest that auditors associate higher levels of risk with higher levels of uncertainty. Higher levels of assessed risk are associated with a higher likelihood that auditors deem necessary the use of a valuation specialist to provide assistance in obtaining assurance over estimates. However, Cannon and Bedard (2017) find that neither the extent of uncertainty, nor auditors' risk assessments, have a direct effect on whether proposed audit adjustments are ultimately booked. The authors interpret this finding as reflecting the technical difficulty auditors have in justifying, negotiating, and implementing auditor-proposed adjustments of uncertain amounts. As a potential remedy, Cannon and Bedard (2017) suggest that specialists can be used to bolster the strength and credibility of evidence auditors present to management when negotiating adjustments.

Griffith et al. (2015a) conduct interviews with experienced auditors to provide a descriptive account of the challenges encountered, and procedures employed, when auditing complex estimates. The authors also provide a theory-based analysis of the causes of these difficulties. A key implication of Griffith et al. (2015a) is that characteristics of the audit methods endorsed by regulators and employed by firms represent an important driver of deficiencies in auditor judgment. For example, auditors tend to verify inputs provided by managers, whereas independently evaluating inputs would appear to facilitate a more rigorous assessment of estimates. Griffith et al. (2015a) also find that the effectiveness of auditors' attempts to overcome a lack of knowledge and expertise through the use of valuation specialists is often limited by coordination challenges and a lack of common vocabulary. The authors argue that alterations to these institutional features offer opportunities to improve audit outcomes related to complex accounting estimates.

Glover et al.'s (2017) survey covers many of the same themes as Cannon and Bedard (2017) and Griffith et al. (2015a) but extends both studies on a number of dimensions. Glover et al. (2017) provide insight regarding different procedures utilized for “highly challenging” versus “typical” complex estimates. The authors distinguish between financial and nonfinancial estimates and discuss technical challenges stemming from auditors' use of specialists. For instance, third-party pricing services often do not share proprietary information necessary for auditors to evaluate amounts obtained from such providers. Glover et al.'s (2017) respondents also note a general lack of valuation knowledge on the part of both management and auditors. The authors' chief conclusion is that standard-setters could clarify audit requirements, especially as they pertain to nonfinancial estimates.

Glover, Taylor, and Wu (2016) focus on an expectations gap between auditors and regulators, particularly PCAOB inspectors. Glover et al.'s (2016) qualitative data suggest that audit partners perceive the technical difficulty surrounding complex estimates as affecting not just judgments and evaluations made by auditors, but also regulators. As a result, issues flagged by inspectors are not always normative audit deficiencies, but can stem from differences of opinion between regulators and practitioners. Glover et al. (2016) draw on psychology theory related to expertise to provide insight on factors that might explain differences of opinion between two experts (i.e., auditors and regulators) performing their respective duties in a competent manner. Glover et al. (2016) make two broad observations: 1) hindsight bias makes uncertain amounts susceptible to "second guessing" by regulators, and 2) auditors and regulators have different expectations regarding the inspection process. As a result, regulatory inspections can have the effect of shifting auditors' focus from audit risk to "inspection risk." Glover et al. (2016) suggest that the different stakeholders in the profession work together to clarify inspectors' expectations, and increase overall expertise regarding complex estimates.

In sum, the stream of research reviewed above has done much to advance auditors', regulators', and scholars' understanding of technical challenges related to auditing complex estimates. While insightful, the above studies stop short of investigating how social dynamics extraneous to the technical difficulty of auditing complex estimates might result in undesirable audit outcomes.

Social Challenges of Auditing Complex Estimates

Although several experiments have examined important audit-related issues in settings that are characterized by uncertainty (e.g., Hackenbrack and Nelson 1996; Salterio and Koonce 1997; Kadous, Kennedy, and Peecher 2003; Bauer 2015), only recently have researchers begun to explicitly focus on social, or psychologically based, implications of auditing complex estimates. This growing steam of mostly experimental research provides an important supplementary perspective to more descriptive studies focusing on technical challenges. As discussed below, the experiment motived and reported in this dissertation is meant to contribute to the consideration of these social challenges of auditing complex estimates.

Griffin (2014) examines how different aspects of uncertainty specific to accounting estimates – subjectivity and imprecision – influence auditor judgment. In an experiment with practicing auditors, participants review information about a fair value estimate and determine the likelihood, and amount, of an audit adjustment. Griffin (2014) manipulates three variables: the subjectivity of inputs used in forming the estimate, the estimate's imprecision (i.e., range of possible values), and the presence or absence of a supplemental footnote disclosure that discusses the estimation process and range of possible values. He finds that the joint effect of high levels of both subjectivity and imprecision increases the likelihood auditors require an adjustment to a complex estimate, while the amount of the required adjustment increases only as imprecision increases. However, adjustment decisions are unaffected by the estimates' subjectivity or imprecision when management provides a supplemental footnote disclosure. That is, supplemental disclosures regarding uncertainty appear to mitigate the effect of other seemingly important factors – estimate subjectivity and imprecision – in determining the extent of an audit adjustment. The implication of these results, consistent with psychology theory related to moral licensing (e.g., Cain, Loewenstein, and Moore 2011), is that auditors assume less responsibility for a possible misstatement when additional disclosures are present.

Emett, Libby, and Nelson (2016) examine auditors' corrective actions and assessments of management bias related to a portfolio of accounting estimates. In an experiment, experienced auditors evaluate a portfolio comprising several Level 2 fair market value securities. Auditors view information about client-reported values and a best estimate determined by the audit team. The distribution of differences between client-reported values and the audit team's estimate for the individual securities within the portfolio varies by condition, but the portfolios' total aggregate overstatement is held constant. The authors operationalize these varying misstatement distributions along two dimensions: overstatement frequency and magnitude. In essence, Emett et al. (2016) abstract away from the technical difficulties of determining whether uncertain estimates are misstated to examine the potential for social challenges triggered by different patterns in discrepancies between reported amounts and the auditors' best estimates.

Emett et al. (2016) find that auditors mechanically apply current auditing standards defining a misstatement as the difference between the auditor's best estimate and the nearest endpoint of a reasonable range (PCAOB 2010a). As a result, the distribution of misstatement across individual estimates within a portfolio leads to predictable differences in the amount of total overstatement corrected. One implication of this finding is that auditing standards could be modified to define a misstatement as the difference between the auditor's estimate and the reported value, not the endpoint of a reasonable range. Such a revision would mitigate variation in audit adjustments driven by mechanical differences in the way misstatements are spread across a portfolio of estimated amounts. Emett et al. (2016) also draw on behavioral theory to predict and find that auditors are likely to perceive more bias in portfolios with a high proportion of relatively small overstatements, or portfolios with overstatements that represent a relatively large percentage of the underlying securities' book values. In sum, Emett et al. (2016) demonstrate that social factors, unrelated to technical difficulties posed by auditing complex estimates, lead to variation in audit adjustment decisions and assessments of management bias.

Three studies draw on psychology theories to experimentally examine how auditors' mindsets can shape the evaluation of complex accounting estimates. Griffith et al. (2015b) experimentally administer a simple intervention that prompts auditor-participants to assume either a deliberative or implemental mindset. Results suggest that a deliberative mindset enhances skepticism applied towards biased estimates. In an application of Griffith et al.'s (2015b) findings, Tegeler (2017) experimentally investigates how the focus of PCAOB inspectors can shape auditor mindsets. She finds that when inspectors focus on audit judgment-quality, versus audit procedures, a deliberative mindset – and improved audit judgments – is more likely. Rasso's (2015) experiment examines how audit documentation instructions can promote different mindsets. Drawing on Construal Level Theory (e.g., Trope and Liberman 2003), documentation instructions designed to encourage auditors to focus on "the big picture" improves auditor judgments, actions, and application of skepticism. Collectively, Griffith et al. (2015b), Tegeler (2017), and Rasso (2015) suggest that, holding technical difficulties constant, subtle differences in the way auditors mentally approach estimates have meaningful implications for audit outcomes.

Somewhat akin to Rasso (2015), three studies delve into social implications stemming from the framing of prescribed audit methodology. Austin, Hammersley, and Ricci (2016) predict and find that audit documentation instructions specifically directing auditors to document evidence inconsistent with managements' preferences can improve auditors' overall interpretation of evidence related to a biased complex estimate. Cohen, Gaynor, Montague, and Wayne (2016) find that audit guidance framed in a way that directs auditors to "support and oppose" managements' assumptions results in higher assessments of misstatement risk and a more balanced search for, and evaluation of, evidence. Maksymov, Nelson, and Kinney (2017) similarly find that framing auditing standards in a way that directs auditors to assess why managements' assumptions are not appropriate increases budgeted time for audit tasks. In sum, these three studies imply that, beyond the technical requirements of standards, the framing of audit directives can trigger a psychological response from auditors and variation in audit outcomes related to complex estimates.

Several studies are relevant to social issues arising from auditors' use of specialists. Griffith (2016a) reports qualitative results from interviews with auditors and in-firm valuation specialists that attest to many of the technical difficulties enumerated above. However, Griffith (2016a) also draws on psychology theory regarding trust to provide insight into how auditors may view specialists as a threat to auditors' jurisdictional claim, and thereby fail to make effective use of specialists' knowledge and expertise. Similarly, Griffith (2016b) reports the results of experiments that test how motivational factors related to the presentation of specialists' work and auditor sensitivity to risk can influence auditors' judgments concerning complex accounting estimates. Focusing on *specialists'* judgments, Bauer, Estep, and Griffith (2017) explore a related theme in an experiment examining specialists' psychological ownership of an issue related to an accounting estimate. They find that a higher level of psychological ownership leads specialists to employ cognition and judgment consistent with more desirable audit outcomes.

Regarding client-hired valuation specialists, Joe, Vandervelde, and Wu (2017) acknowledge psychological reasons for how the degree of quantification auditors' observe in specialist-prepared reports can shape the nature and extent of planned testing surrounding complex estimates. The authors find that in high risk scenarios, auditors tend to pay less attention to subjective valuation inputs if specialists' reports contain a high degree of quantification. Because subjective inputs are highly susceptible to management bias, Joe et al. (2017) illustrate a situation where social dynamics are likely to increase the likelihood of an undesirable audit outcome. Pyzoha, Taylor, and Wu (2016) also examine how auditors respond to client-hired specialists. The authors manipulate audit firm tone-at-the-top and find that that, *ceteris paribus*, auditors tend to over rely on client-hired specialists when firm leadership stresses performance goals rather than audit quality.

Kachelmeier and Van Landuyt (2017) document an interaction between measurement uncertainty and seemingly innocuous, casual social bonds likely to arise between auditors and clients. The authors find that the effects of uncertainty and auditor-client social bonds are interdependent. In isolation, neither construct solely drives auditor leniency towards the client, but together, uncertainty and social bonds prompt auditors to give clients the "benefit of the doubt," despite evidence suggesting that corrective action is warranted. One implication of this result is that specialists and other non-client facing members of the engagement team are likely to provide more dispassionate judgments given the relative lack of opportunity to form casual social bonds with client personnel.

Finally, the experiment reported in this dissertation is based on behavioral arguments for how focusing on management bias can sometimes be detrimental to overall audit quality. I find that when environmental factors place an imbalanced emphasis on bias, auditors are less sensitive to risks related to measurement imprecision, another important risk factor surrounding complex estimates. This deficiency in auditor judgment causes insufficient audit effort when the risk of bias is low. Like the other socially directed studies reviewed above, my experiment reveals psychologically based challenges distinct from the technical difficulty of auditing complex estimates.

A Framework for Considering Challenges Related to Auditing Complex Estimates

Broadly speaking, the above review suggests that studies focusing on technical versus social challenges of providing assurance over complex estimates typically take different approaches. Scholars focused on technical challenges tend to employ more descriptive, survey-based, and qualitative methods. Researchers investigating social challenges are more likely to utilize laboratory experiments rooted in psychology and economic theories. While both approaches certainly offer unique strengths valuable for answering individual studies' particular research questions, the results and implications of these separate streams should not be viewed in isolation.

Prior research on technical challenges often seems to implicitly assume that auditors are rational agents, but that environmental or task factors external to the auditor, or internal factors like limited capacity and capability, restrict the ideal fulfillment of the audit function. On the other hand, studies focused on social challenges can seem to implicitly assume that auditors have potentially unlimited capability to adequately discharge their duties, but are subject to psychologically based judgment biases or other faults and foibles of human nature. Intuitively, deficiencies in audit outcomes surrounding complex accounting estimates likely reflect both points of view: environmental, task, and auditor-specific factors limit the capability of auditors predisposed to behave in biased, boundedly rational ways.

It follows that a fuller understanding of the implications of recent research related to complex estimates can be gained from considering technical challenges in light of social challenges, and vice-versa. To facilitate a more complete picture of auditing complex estimates, I propose a framework to 1) assist in the simultaneous consideration of technical and social challenges and 2) guide future research to fill in the gaps in our current understanding by identifying additional challenges and solutions. The framework, detailed in Figure 1, is based on the three categories of factors that affect the audit of estimates specified by Bratten et al. (2013): environmental factors, task factors, and auditor-specific factors. Within each category, I list specific factors identified by Bratten et al. (2013). Drawing on the papers review above, I then identify specific challenges and remedies that correspond to each factor, categorizing each as technical or social.

Several insights emerge from this framework. Generally speaking, the following discussion speaks to the importance of viewing technical and social challenges of complex estimates in light of one another. Socially directed studies can often enhance or expand the findings of studies focused on technical challenges. For example, Cannon and Bedard (2017) argue that justifying, negotiating, and implementing adjustments to estimates is technically difficult for auditors. However, Kachelmeier and Van Landuyt (2017) suggest a social cause that likely contributes to Cannon and Bedard's (2017) finding: auditors give clients the "benefit of the doubt" in the presence of uncertainty and casual social bonds.

In other cases, seemingly logical responses to technical challenges can sometimes create new social challenges by triggering psychological judgment biases. For example, Christensen et al. (2012) and Glover et al. (2017) call for increased disclosure regarding the magnitude of uncertainty surrounding estimates and limitations in assurance provided by auditors. However, Griffin (2014) indicates that such an initiative would likely be detrimental to audit quality as auditors respond to increased disclosures as a license to assume less responsibility for possible misstatements. Future research could examine the extent to which benefits to financial statement users of more disclosure surrounding complex estimates are offset by Griffin's (2014) finding that increased disclosures result in a lower propensity for auditors to correct misstatement amounts.[5]

Researchers have devoted substantial attention to auditors' use of valuation specialists. While specialists' technical knowledge and expertise appears necessary for evaluating many complex estimates given shortcomings on the part of auditors and management, auditors' utilization of specialists is not without friction. Studies focused on technical (Griffith et al. 2015a; Cannon and Bedard 2017; Glover et al. 2017) and social (Griffith 2016a, b; Bauer et al. 2017; Joe et al. 2017; Pyzoha et al. 2016) challenges have identified both benefits and complications from using specialists. However, review of the framework reveals that extant research has yet to clearly specify situations when potential benefits of using specialists (e.g., Kachelmeier and Van Landuyt 2017) do or do not outweigh any drawbacks (e.g., Griffith 2016a).

[5] Although not directly related to auditor judgements, Majors (2016) provides a counterpoint to the potential costs of additional disclosure implied by Griffin (2014) with an experiment that demonstrates how range disclosure can constrain aggressive reporting, especially for individuals with personalities associated with a higher propensity for aggressive reporting.

Scholars focused on technical challenges tend to make arguments about the broad nature of standards governing complex accounting estimates. For example, Christensen et al. (2012) question whether different levels of assurance, or even negative rather than positive assurance, would be a more reasonable standard for audits of complex estimates. Griffith et al. (2015a) note that auditor judgments could be improved by utilizing an evaluation, versus verification, approach to estimates. Glover et al. 2017 go so far as to suggest that regulators consider “when, if at all, auditors should use management’s assumptions when developing independent estimates” (81). Studies examining social challenges add the important insight that beyond the content of auditing standards and guidance, the framing of such directives is an important determinant of audit outcomes (Austin et al. 2016; Cohen et al. 2016; Maksymov et al. 2017).

Directly relevant to the experiment described in this dissertation, studies focused on the technical challenges of complex estimates acknowledge the high risk of management bias and suggest the importance of auditor attention to the potential for bias (e.g., Bratten et al. 2013; Griffith et al. 2015a). However, the results described in Chapter IV suggest that an imbalanced emphasis on bias can leave auditors exposed to risks stemming from measurement imprecision when the risk of bias is low. I suggest that a more balanced emphasis on bias and imprecision is important for ensuring diligent audit effort is directed towards complex estimates.

To effectively overcome both technical and social challenges of auditing estimates, it is important to consider each class of difficulty within the context of the other. The first step in doing so is the clearly differentiate between technical and social challenges. The review and framework above provides a structure for identifying and assessing technical and social challenges related to complex estimates. By applying a thorough and systematic approach to these difficulties, future researchers can identify more challenges and, importantly, more effective responses.

CHAPTER III
Institutional Background, Theory, and Hypothesis

Measurement Imprecision

Measurement imprecision is inherent to complex accounting estimates. Broadly speaking, this construct captures characteristics of a reported amount that inhibit the precise observation of the amount's true value. For example, measurement imprecision can be driven by uncertainty (e.g., Christensen et al. 2012; Cannon and Bedard 2016), subjectivity (e.g., Braun 2001; Griffin 2014), or complexity (e.g., Bratten et al. 2016; Fang et al. 2017). A high level of measurement imprecision demands a high level of audit effort in response (Griffith et al. 2015a; Glover et al. 2017).

Barring outright fraud, the extent of potential management bias is determined by the magnitude of measurement imprecision. That it, imprecision facilitates bias in that it provides leeway in financial reporting (e.g., Lundholm 1999). Regardless, even in the absence of bias, measurement imprecision creates the possibility of (unintentional) misreporting. As described later, my study mitigates this natural confound between bias and imprecision by treating imprecision as a constant. Consistent with the context of auditing complex estimates, I assume imprecision is large in magnitude, thus giving rise to a significant source of risk.

Institutional Emphasis on Management Bias

Recent developments in the current audit environment have emphasized auditors' responsibility to consider and respond to risks arising from management bias and fraud. In this subsection, I outline prominent factors contributing to this institutional emphasis that directly impact audits of complex accounting estimates.

Professional Auditing Standards

Following several high-profile accounting scandals in the early 2000s, guarding against fraud has become a higher priority for standard setters and the audit profession (e.g., AICPA 2002). In line with this shift, professional auditing standards often place a skewed emphasis on risks arising from bias, relative to measurement imprecision, when discussing complex accounting estimates. SAS 99 (AICPA 2002) contains an extensive discussion of estimates' susceptibility to intentional bias (paragraph 54) and specific directives for auditors to review accounting estimates for bias (paragraphs 63-65). The only mention in SAS 99 of concepts underlying measurement imprecision is in relation to how imprecision creates or elevates the risk of bias, not how imprecision might result in misreporting regardless of management bias. Similarly, AS 2110 "Identifying and Assessing Risks of Material Misstatement" identifies accounting estimates as an area where management might manipulate the financial statements (e.g., paragraph 05; PCAOB 2010b), but does not specifically link estimates to risks arising from imprecision. Likewise, AS 2810 "Evaluating Audit Results" contains a paragraph (27) requiring explicit consideration of the potential for bias in accounting estimates, but does not reference the impact of estimates' imprecision on misstatement risk (PCAOB 2010a).

More generally, a notable aspect of SAS 99 is its mandate for "fraud brainstorming" meetings during the planning phase of every audit. Fraud brainstorming involves the entire audit team and is intended to facilitate explicit identification and communication of engagement-specific factors impacting the likelihood of management bias and fraud. Brazel, Carpenter, and Jenkins (2010) document a link between high-quality instances of fraud brainstorming sessions and auditor response to fraud risks. Risk factors distinct from bias, however, are not afforded similar platforms to attract auditor attention. Given that standards identify complex estimates as particularly *susceptible* to management bias, fraud brainstorming sessions represent a likely opportunity for engagement teams to explicitly articulate the *specific* risk of an individual audit client exhibiting bias in estimates.

Emphasis notwithstanding, professional auditing standards certainly do not ignore the implications of measurement imprecision. PCAOB Auditing Standards 2501 and 2502 (formerly classified as Interim Standards AU 342 and 328) are the primary standards specifically addressing accounting estimates that govern auditors of U.S. publicly traded companies (PCAOB 2003a, b).[6] AS 2501, 2502, and AU-C 540 (the AICPA's equivalent standard) contain substantive discussions regarding the relationship between higher levels of complexity, subjectivity, or uncertainty and a higher risk that estimates are misstated. However, these standards also prominently discuss risks arising from bias, while the standards described above exclusively highlight management bias when discussing estimates, thus conveying a decidedly imbalanced emphasis.

Further, the evolution of current standards suggests that regulators are *increasing* the emphasis placed on auditors' responsibility to consider the potential impact of management bias on accounting estimates and subjective amounts. The AICPA's AU-C 540 (AICPA 2012) replaced AU 342 and 328 (AICPA 1989; 2003) for audits of private companies. A comparison of the more current language used in AU-C 540 to language in the superseded standards is informative regarding this trend.[7] As a coarse indicator, AU 342 and 328 use the word "bias" a

[6] PCAOB Interim Standards AU 342 and 328 were adopted from existing AICPA standards upon formation of the PCAOB under the Sarbanes-Oxley Act of 2002. Effective December 31, 2016, PCAOB standards were reorganized with AU 342 and 328 becoming AS 2501 and 2502, respectively. The reorganization, which also affected other standards referenced in this subsection, did not substantively alter the contents of the standards. As mentioned below, the PCAOB and IAASB are both in the process of developing new comprehensive standards related to auditing complex estimates.

[7] Although AU-C 540 ostensibly "does not change or expand [the] superseded AU sections in any significant respect," new language was adopted for the standard (AICPA 2014, 9). ISA 540, which mirrors AU-C 540 almost verbatim, provides guidance for auditors under purview of international standards (IFAC 2008).

combined three times, while AU-C 540 mentions “bias” 29 times. The newer standard alerts auditors to management bias in its first paragraph (AU 342 first mentions bias in paragraph 4, AU 328 in paragraph 33) and contains several developed subsections and paragraphs (not present in the superseded standards) discussing risks arising from management bias.

An evaluation of the relative emphasis on bias versus imprecision conveyed by professional standards is inherently subjective. Regardless, when considering the broad scope of auditing standards reviewed above, risks arising from possible management bias consistently appear as a substantial and growing point of emphasis. This emphasis on bias is rarely accompanied by an equivalent emphasis on risks arising from measurement imprecision. Further, the PCAOB and the IAASB are currently in the process of considering extensive revisions to existing standards specifically addressing complex accounting estimates (PCAOB 2014; IAASB 2016), and have identified this process as an opportunity to implement even “more robust requirements” related to “consideration of indicators of management bias” (IAASB 2016, 7).

It is important to note that such efforts to increase auditors’ attention to bias are not necessarily misguided. Bias is a significant source of risk threatening complex estimates and the possibility exists that auditors have previously not given bias sufficient consideration. Regardless, my premise is that emphasizing bias in a manner that sets it apart from imprecision (e.g., as seen in directives contained in SAS 99, including fraud brainstorming, AS 2110, AS 2810, and projected trends in standard setting for estimates) might result in insufficient auditor attention to imprecision when the risk of bias is low.

Regulatory Inspections and Audit Practitioner Methodology

PCAOB inspections of audit firms routinely focus on procedures performed around accounting estimates (Griffith et al. 2015a). While inspections evaluate multiple components of audits, the PCAOB’s 2016 Staff Inspection Brief specifically identifies procedures performed in response to “the potential for management bias” in “fair value measurements and other accounting estimates” as a point of emphasis for inspectors (PCAOB 2016, 5). This focus echoes past pronouncements by the PCAOB that link auditors’ professional skepticism with the review of accounting estimates for management bias (e.g., PCAOB 2012).

SAS 99 calls for audit training to incorporate fraud detection and prevention (AICPA 2002). While the impact of this call on audit firms’ training curricula is difficult to assess, firms strongly advocate methodology that reflects vigilance for management bias, especially when auditing accounts that require significant judgment (e.g., Bell, Peecher, and Solomon 2005; Glover and Prawitt 2013; CAQ 2017). In interviews conducted by Griffith et al. (2015a), when auditors describe the process of evaluating whether estimates are reasonable in light of the audit evidence, “[a]uditors’ descriptions focus mainly on detecting bias in management’s estimates” (849). Although auditors might not always effectively *detect* management bias or fraud (e.g., Hammersley, Bamber, and Carpenter 2010; Boritz, Kochetova-Kozloski, and Robinson 2015), the above suggests that regulators and practitioners strongly emphasize the importance of auditors’ sensitivity to risks arising from management bias.

Improving Auditors’ Approach to Complex Estimates

Because complex accounting estimates are particularly susceptible to management bias, recent studies have focused on improving auditors’ ability to address bias in estimates.[8] Griffith et al. 2015b, Rasso (2015), and Tegeler (2017) demonstrate that auditors’ mindsets can play an important role in identifying likely indicators of management bias, making appropriate assessments of the reasonableness of a biased estimate, and taking actions necessary to correct

[8] See Bratten, Gaynor, McDaniel, Montague, and Sierra (2013) for a broad review of prior research that speaks to how auditors approach complex estimates.

financial reporting. Austin, Hammersley, and Ricci (2016) show how audit documentation instructions impact auditors' interpretation and evaluation of evidence related to a biased estimate. Emett, Libby, and Nelson (2016) and Backof, Martin, and Thayer (2016) speak to how the distribution of misstatements across a portfolio of estimated amounts and review of prior-period estimation accuracy, respectively, can shape auditors' assessments of management bias. Kachelmeier and Van Landuyt (2017) document how auditor-client social bonds give rise to insufficient adjustment of biased reporting in accounts with measurement uncertainty. Although not always focused specifically on complex estimates, a vast literature on auditors' response to fraud risks similarly illuminates factors that inhibit or improve auditors' ability to effectively deal with risks arising from biased financial reporting (e.g., Hoffman and Zimbelman 2009; Bowlin 2011; Hammersley 2011; Hammersley, Johnstone, and Kadous 2011; Kachelmeier, Majors, and Williamson 2014).

While prior studies provide insight into how auditors can better respond to management bias and fraud, auditors face risks from multiple sources. My incremental contribution lies in examining how emphasizing risks related to bias might impact auditor sensitivity to another important source of risk: measurement imprecision. Theory elaborated below suggests that when the audit environment places a strong emphasis on one consideration, auditors are likely to be less sensitive to other important considerations. Applying this premise to complex accounting estimates, for which both bias and imprecision are significant sources of risk, provides a more complete picture of how efforts intended to improve auditors' response to management bias are likely to impact *overall* audit quality.

How Emphasizing Risk Impacts Auditors' Consideration of Risk

Emphasis typically increases the salience and perceived importance of the emphasized factor, and can alter subsequent judgments and decisions (e.g., Taylor and Fiske 1978; Elliott 2006). This effect of emphasis extends to individuals' behavior in the face of risk. For example, Weinstein, Grubb, and Vautier (1986) find that emphasizing the link between seat belt use and susceptibility to personal risk increases individuals' use of seat belts. However, Weinstein et al. (1986) do not speak to what effect, if any, emphasizing seat belt use would have on *other* behaviors that impact personal safety when driving an automobile, such as using a turn signal.

On one hand, psychology theory related to attention suggests that individuals allocate cognitive resources from a fixed pool of processing capacity and have difficulty dividing attention between multiple stimuli (e.g., Kahneman 1973; Duncan 1980). Theory and experimental results from a wide range of contexts demonstrate how specific motivational factors and characteristics of stimuli influence individuals' perceptions of cue relevance and, in turn, propensity to thoroughly and objectively consider all relevant information (e.g., Einhorn and Hogarth 1981; Petty and Cacioppo 1986; Maheswaran, Mackie, and Chaiken 1992; Griffith, Nolder, and Petty 2017). It follows that emphasizing one factor is likely to come at the expense of individuals' attention towards other relevant factors. On the other hand, this conclusion is not self-evident given standard economic reasoning that individuals generally respond to explicit monetary incentives that would promote careful consideration of relevant information, especially in transparent or well-defined settings (e.g., Smith 1991; Bonner and Sprinkle 2002).[9]

To help reconcile these viewpoints and develop a prediction for *when* and *how* emphasizing source(s) of risk auditors face impacts audit effort, I incorporate theory related to

[9] Additionally, Farrell, Goh, and White 2014 provide evidence that performance-based incentives activate more deliberative, systematic information processing.

dual process models of human thought (e.g., Stanovich and West 2002; Evans and Stanovich 2013; Griffith, Kadous, and Young 2016). Dual process models comprise a broad swatch of psychological theories that generally differentiate between cognitive processes commonly employed by individuals making judgments and decisions.[10] At one end of the spectrum are relatively simple, intuitive processes that often rely on heuristic decision rules. At the other end of the spectrum are more thorough, deliberative, and systematic mental processes.

Because heuristic processing requires less effort, individuals tend to rely on simple decision rules *unless* the individual determines that more systematic processing is needed (Kahneman and Frederick 2005). While heuristic processing can facilitate proper decisions at less cognitive cost in many situations, it can also lead to systematic errors (e.g., Tversky and Kahneman 1974). Chen and Chaiken (1999) and Chen, Duckworth, and Chaiken (1999) argue that heuristic processing is most likely to occur when potential cues are available, accessible, and applicable. Therefore, placing emphasis on one cue not only elevates the prominence of that cue, but likely encourages individuals to engage in heuristic processing on the basis of information conveyed by that cue, potentially impairing the ability to determine whether more systematic processing is warranted.

Risks surrounding complex accounting estimates arise due to the potential for management bias and the presence of measurement imprecision. Given the extreme estimation uncertainty documented by recent research (Christensen et al. 2012; Cannon and Bedard 2016), I make a simplifying assumption that risks posed by measurement imprecision in this setting are constant and high in magnitude.[11] When environmental factors place an imbalanced emphasis on

[10] See Strack and Deutsch (2015) for a broad review of dual process theories, and Griffith et al. (2016, 2017) for discussions of dual-process implications for auditing.
[11] Given that risks related to measurement imprecision are not constant in the real world, my study does not speak to the effects of variation in measurement imprecision (e.g., Griffin 2014) or how different levels of imprecision might

management bias, auditors are likely to rely heuristically on information conveyed by that cue. That is, the relative risk of management bias (i.e., high versus low risk) becomes a simple decision rule auditors can utilize when allocating effort towards auditing complex estimates.[12] When the risk of bias is high, auditors are likely to respond with a high level of audit effort due to the information conveyed by the heuristic cue appropriately signaling the need for a diligent response. When the risk of bias is low, however, auditors using management bias as a heuristic cue are likely to "lower their guard" more than what would be warranted given a systematic consideration that more fully takes risks related to measurement imprecision into account.

When environmental factors place a balanced emphasis on management bias *and* measurement imprecision, the relative risk of management bias is less likely to serve as a heuristic cue and, as a result, auditors are likely to engage in relatively more systematic processing. While effort will still be high when the risk of management bias is high, a more systematic approach will allow auditors to better appreciate, and more appropriately respond to, risks arising from measurement imprecision when the risk of bias is low. Formally stated, I test the following hypothesis.

> **Hypothesis:** Regardless of whether environmental factors place a balanced emphasis on risks related to management bias and measurement imprecision, or an imbalanced emphasis on management bias, auditors will exert a high level of audit effort when the risk of management bias is high. Relative to a balanced emphasis on risks related to both management bias and measurement imprecision, an imbalanced emphasis on the risk of bias will cause auditors to choose a significantly less optimal level of costly audit effort when the risk of management bias is low.

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interact with the constructs I manipulate. However, holding imprecision constant provides a clean setting to develop and test theory regarding the joint effect of institutional features in the current audit environment that place an imbalanced emphasis on management bias and different levels of the risk of bias.

[12] Risks vary across clients, such that auditors routinely encounter different magnitudes of risk in different settings (e.g., Bhattacharjee, Maletta, and Moreno 2007; Hallman 2017). Observable differences between clients such as perceived management integrity and internal control strength are examples of factors likely to give rise to relative differences in the risk of management bias.

CHAPTER IV
Method and Design

Task

To capture the most important incentives and dynamics relevant to the real world setting of interest while still providing a clean test of theory, I utilize a research design following the tenets of experimental economics. Specifically, I construct a game that represents a strategic interaction between two players: a reporter and an auditor. My setting operationalizes a high level of risk arising from measurement imprecision, warranting a diligent response from auditors, but holds that risk constant across conditions to test for the joint impact of management bias risk (manipulated within-participants) and environmental factors emphasizing source(s) of risk (manipulated between-participants) on audit effort. Abstract terminology and student participants help prevent other contextual factors common in real audits from confounding the behavioral phenomenon I seek to test (Haynes and Kachelmeier 1998).

The experimental instructions and task are administered through linked computers operating the z-Tree interface for economic experiments (Fischbacher 2007). To ensure participants understand the task, the instructions (which are identical for both participant types) are extensive. At their own pace, participants work though several screens of information that explain the parameters of the game and include multiple embedded comprehension checks and a quiz reviewing the most important elements. Incorrect answers prompt remedial instructions. Participants must respond correctly to all comprehension checks and quiz questions before beginning the task.

The reporter, referred to in the experimental materials as “Player A,” is the first mover. The reporter’s job is to estimate the value of an asset based on a private signal that is noisy, but unbiased. Specifically, the signal is equal to the true value of the asset plus some unknown amount of noise randomly drawn from a discrete uniform distribution over the interval -15 to 15. Because the signal is within the asset's true value plus or minus 15, the reporter's estimate is constrained to be within plus or minus 15 of the signal. To aid in comprehension, the task is presented to participants as guessing the number of marbles in a sealed container. The number of marbles is representative of true asset value and the reporter's guess corresponds to a complex accounting estimate. Participants are told that because the container of marbles is sealed, the reporter cannot count the marbles and must make a guess after viewing a measurement of the container's weight provided by an imprecise scale.

For making the guess, the reporter receives a fixed payment of $5. My first manipulation, described in detail below, involves the determination of an additional payment to the reporter that ranges from $0 to $15. The determination of this additional payment, manipulated within-participants, creates incentives for the reporter to exhibit either upward bias or accuracy (to the extent possible given the inherent imprecision of the signal) in his/her estimate. Because the private signal is unbiased in expectation, reporters incentivized to be accurate are best served by simply making their estimate equal to the private signal.

Participants in the auditor role, "Player B," are matched with a reporter and view the estimate, but not the imprecise signal. Thus, while the auditor is always aware of whether s/he is paired with a reporter incentivized to be biased or unbiased, the auditor does not know the extent to which the reporter's estimate deviates from the imprecise signal, and neither player knows the asset's true value. The auditor is endowed with $20, but faces exposure to a penalty analogous to the negative consequences of an audit failure including exposure to litigation, costs of a restatement, loss of reputation, or sanctions due to regulatory inspections that detect a lack of diligence (e.g., Palmrose 2000; Chaney and Philipich 2002; Glover, Taylor, and Wu 2016).

The auditor's potential penalty is based on the absolute value of the difference between the reporter's estimate and the true asset value. Specifically, if the reporter's guess is off by more than 5 marbles, but less than 15 marbles, the number of marbles by which the guess is off equates to the amount of the auditor's penalty in U.S. Dollars.[13] Capturing the notion of materiality, the auditor does not face any penalty if the reporter's guess is within 5 marbles of the actual number in the container. For guesses that are off by 15 marbles or more, the auditor's exposure is capped at $15.

To mitigate the likelihood of incurring the penalty, the auditor chooses a level of costly audit effort (labeled in the experimental materials as a "Protection Level") that ranges from 1 to 10. The auditor must pay $0.50 for the lowest level of audit effort, and an additional $0.50 for each incremental level. This costly action represents my primary dependent variable. As shown in Table 1, Panel A, the probability that the auditor incurs a penalty decreases as audit effort increases. Although the game does not incorporate a specific realization of audit evidence or an explicit adjustment to the estimate generated by the reporter (Kachelmeier and Van Landuyt 2017), costly effort in my setting nevertheless protects auditors from a penalty much in the same way that high levels of audit effort in the real world increase auditors' ability to detect misreporting or avoid punitive actions from inspectors citing lack of diligence.

The auditor's effort choice affects the probability that the *reporter* incurs a separate penalty that ranges from $0 to $5. This penalty captures costs imposed on reporters when auditors increase scrutiny on reported amounts or take corrective actions for detected errors (e.g.,

[13] GAAS requires auditors to obtain reasonable assurance that financial statements are free from material misstatements whether due to fraud or error (AICPA 2011). In my setting, bias (i.e., fraud) suggests a risk of overstatement, but imprecision (i.e., error) can result in overstatement or understatement. While, in practice, auditors might face greater financial exposure for reports misstated due to fraud, equal exposure to overstatement and understatement in my setting biases *against* auditor-participants neglecting the impact of measurement imprecision.

Gibbons, Salterio, and Webb 2001).[14] Specifically, the amount of the reporter's penalty is equal to $1 for each marble by which the reporter's guess is off in excess of 5 marbles. For guesses that are off by 10 marbles or more, the penalty is capped at $5. Table 1, Panel B shows the relationship between audit effort and the probability that the reporter incurs this penalty. Whether or not the reporter incurs a penalty is determined independently of the auditor's penalty, thus mitigating the effects of retribution or fairness (e.g., Fehr and Gächter 2000) that are extraneous to the theory my experiment is designed to test. The auditor's and reporter's payoff functions are summarized below:

> Reporter's payoff = $5 + Additional Compensation ranging from $0 to $15 – Reporter's Penalty ranging from $0 to $5 (if incurred)
>
> Auditor's payoff = $20 – Cost of Audit Effort – Auditor's Penalty ranging from $0 to $15 (if incurred)

Participants and Procedure

Participants consist of 90 undergraduate students enrolled in introductory accounting classes at a large public university who are randomly assigned a role analogous to either an auditor (n = 68) or reporter (n = 22). Each experimental session has exactly two reporters, with the rest of the participants assigned to the role of auditor. Although the experimental task takes place between auditors and reporters interacting in pairs, participants are aware that multiple auditors may be matched with a single reporter and that the decisions made by one randomly selected matched auditor are used for determining each reporter's final payment. Matching multiple auditors with a single reporter helps to prevent idiosyncratic differences in reporters'

[14] Although companies that issue misstated financial statements also face exposure to other potential costs that are *reduced* through high audit effort (e.g., litigation and subsequent restatements), I abstract from these considerations to simplify the experimental setting. These elements could easily be incorporated into the reporter's payoff function without altering equilibrium behaviors, but would significantly increase the complexity of the game.

estimates from confounding the experimental manipulations as drivers of observed differences in auditors' effort choices.[15]

The experimental task is repeated by anonymous auditor/reporter pairings for two sets of five rounds (10 rounds total). Monetary balances do not carry over from round to round, and outcomes (such as the selected level of audit effort and true asset value) are not revealed until the end of the session. Accordingly, each round represents an independent one-shot game. While multi-period considerations like audit pricing, reputation building, and client retention (e.g., Calegari, Schatzberg, and Sevcik 1998; Mayhew 2001; Schatzberg, Sevcik, Shapiro, Thorne, and Olusegun Wallace 2005) are certainly relevant to real world audits, incorporating such considerations into my setting would add unnecessary complications that are unrelated to the theory I test.

One potentially important element of multi-period games that my setting does not capture is auditors' ability to learn from past audit failures. While improvements driven by outcome feedback have been detected in abstract economic games (e.g., Koch and Schmidt 2010), it does not necessarily follow that real-world auditors appropriately learn from experience (Waller and Felix 1984; Hogarth 1991). Given that task complexity reduces the benefits of auditor learning from outcome feedback (Leung and Trotman 2005), it seems unlikely that, in practice, feedback from audits of complex estimates would eliminate the behavioral effect I examine.

True asset values and the reporter's noisy signal change in each period, but realizations of these random amounts are determined in advance and held constant across experimental sessions. After the first set of five rounds, auditor/reporter pairings rotate and participants

[15] Specifically, having only two reporters per session results in the minimum possible variance in the estimates actually viewed by auditors while still allowing auditors to be matched with a *different* reporter in the alternative within-participants bias risk conditions, as explained below.

complete the second set of five rounds. Prior to the start of each set of five rounds, participants are reminded of the method used to determine reporters' additional compensation (manipulated within-participants) for that particular set of five rounds. Before the start of each set of five rounds, auditors provide an assessment of the overall risk they face in the upcoming set of five rounds.

At the end of the second set of five rounds, participants complete a post-experimental questionnaire. Following the questionnaire, the outcomes from one randomly selected round from the first set of five rounds and one randomly selected round from the second set of five are used to determine participants' payoffs, which are displayed on the computer screen. Participants are then paid and dismissed. On average, participants earn $29.94, including a $5 "show up" payment, for an approximately 60-minute experimental session.

Manipulation of the Risk of Management Bias

As noted previously, I use the additional compensation included in the reporter's payoff function to manipulate, within-participants, the risk of management bias. The method used to determine the additional compensation changes between the first and second set of five rounds. Importantly, the instructions fully describe both compensation schemes prior to start of the first round such that, as in the real world, auditors are aware from the outset that the risk of bias can be relatively high or low.[16] The ordering of the two compensation schemes is counter-balanced between experimental sessions to control for order effects.

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[16] To the extent that the within-participants manipulation of reporters' incentives elevates auditors' attention to reporter bias, this design feature would bias the results in favor of a main effect, but not the predicted *interaction*. It is worth noting that measurement imprecision is similarly demonstrated to auditors through observation of multiple reports, of varying magnitudes, throughout the course of the ten experimental rounds. This design feature would bias *against* auditors' neglecting risks arising from imprecision.

When a reporter is incentivized to exhibit bias, his/her additional compensation increases as the number of marbles s/he guesses increases. Recall that the reporter can guess any amount between the signal *minus* 15 and the signal *plus* 15. If a reporter in the "high risk of bias" condition guesses the signal *minus* 15 (the lowest possible guess), his/her additional compensation is $0. The reporter receives an additional $0.50 for each marble s/he guesses in excess of this minimum guess, up to a maximum of $15 for guessing the signal *plus* 15. Figure 2, Panel A graphically depicts this compensation scheme. All else equal, marginal gains from inflating the report outweigh associated increases in the reporter's expected penalty (which ranges from $0 to $5). Thus, a reporter in the high risk of bias condition maximizes expected wealth by making the highest possible estimate given the signal observed.

When a reporter is incentivized to be unbiased, his/her additional compensation increases as the *actual* number of marbles in the container increases, as opposed to the number of marbles guessed. Recall that the signal can be any amount between true asset value (i.e., the actual number of marbles in the container) *minus* 15 and true asset value *plus* 15. If the actual number of marbles in the container is equal to the signal *minus* 15 (the lowest possible realization of asset value), the reporter's additional compensation is $0. The reporter receives an additional $0.50 for each marble in the container beyond this minimum possible amount, up to $15 if the actual number of marbles in the container is equal to the signal *plus* 15. Figure 2, Panel B graphically depicts this compensation scheme. Because the reporter's estimate does *not* influence his/her additional compensation in this condition, but can contribute to the amount of the reporter's penalty, a reporter in this condition maximizes expected wealth by making a guess that is equal to the private signal (which is a noisy, but unbiased estimate of truth).

The reporter's incentives in the low risk of bias condition bear some similarity to Hales (2007), but in a context analogous to financial reporting rather than investing. Hales (2007) provides evidence that directional preferences bias investors' valuation judgments even when investors are incentivized to make accurate judgments. In my setting, when a reporter's estimate does not increase his/her payment, the reporter's payment does increase as the *actual* number of marbles in the container increase. Motivated reasoning (Kunda 1990), which forms the theoretical underpinning for Hales (2007), suggests that due to preferences for a higher number of marbles in the container, even reporters in the low risk of bias condition are likely to exhibit some degree of upward bias in their estimates. Thus, beyond implications for auditing, reporter behavior in my setting has potential to offer insights into *unintentional* biases surrounding the financial reporting of uncertain amounts.

From an auditing perspective, the potential for upward bias, even when the risk of bias should be low, represents a threat to audit outcomes conceptually distinct from auditors neglecting risks related to measurement imprecision. Motivated reasoning suggests that reporters are likely to be at least somewhat biased, despite incentives to be unbiased, as long as they possess directional preferences for the amounts being estimated. The potential for such unintentional bias suggests the possibility that auditors might underestimate the effects of management bias in situations where the risk of bias should ostensibly be low. In other words, under-auditing when the risk of bias is low could result from auditors relying heuristically on the relative risk of bias, as argued in Chapter III, or from auditors failing to adequately anticipate the presence of *unintentional* upward bias despite reporters' incentives to be accurate.

While I do not formalize the preceding argument as a hypothesis, allowing for the possibility that reporter-participants might not exhibit wealth-maximizing behavior not only offers an opportunity for insights stemming from unintentional reporting biases, but also illustrates the importance of utilizing human participants, rather than programmed algorithms, for the role of reporter. Auditors plan audit procedures in response to *risks*, not known reporting outcomes. Operationalizing the risk of management bias through financial reporting incentives, and not more directly through imposed reporter behavior, facilitates a more externally valid experimental setting and, by extension, a more informative normative evaluation of auditor behavior in response to actual and perceived risk. More importantly, the possibility that reporters exhibit upward bias even when incentivized to be impartial underscores the importance mitigating under-auditing when the risk of bias is low. Future research could directly investigate whether auditors adequately anticipate unintentional reporting biases. In the context of my experiment, reporter bias in situations where the risk of bias should be low exacerbates negative consequences of insufficient audit effort stemming from insensitivity to measurement imprecision.

Manipulation of Environmental Emphasis on Risk

I operationalize the between-participants manipulation of an environmental emphasis on bias ("bias-emphasis") versus bias and imprecision ("dual-emphasis") through wording that appears only to auditors immediately prior to the instructions and prior to the start of each set of five rounds. Across conditions, the instructions provide *all* participants with extensive training on how reporters' incentives (manipulated within-participants) and measurement imprecision (held constant across conditions) could impact reporters' estimates. However, the additional wording that places emphasis on bias versus bias and imprecision differs. Specifically, wording the bias-emphasis condition emphasizes how the reporter's incentives are likely to impact his/her report in the high and low risk of bias condition. Wording in the dual-emphasis condition emphasizes both the reporter's incentives and the imprecision of the scale used to weigh the marbles.

Specifically, when the risk of bias is high, both the bias- and dual- emphasis conditions explicitly emphasize that "Player A has incentives to always guess more marbles than indicated by the measurement provided by the scale." When the risk is low, both emphasis conditions remind participants that "Player A's incentives are best served when he or she guesses a number that is close to the measurement provided by the scale." Regardless of the risk of bias, the dual-emphasis condition provides the additional emphasis that "the fact that the scale used to weigh the marbles is imprecise contributes to the possibility that the measurement viewed by Player A, and ultimately his or her guess, might not be very close to the actual number of marbles in the container." Figure 3 shows a timeline of the experimental session and the complete wording used to convey the between-participants emphasis conditions. With the exception of what is depicted in Figure 3, Panels B and C, I hold all other wording constant across conditions.

The abstract nature of the task and manipulation is intended to capture the effects, and speak to behavioral consequences, of a broad set of environmental factors that contribute to an institutional emphasis on bias such as fraud brainstorming sessions. That is, although participants in my setting do not actually engage in brainstorming, just as fraud brainstorming meetings are intended to ensure that all members of the audit team are aware of the engagement-specific risks stemming from intentional bias, wording in the bias-emphasis condition reminds auditor participants how reporters' incentives are likely to shape reporter behavior. The dual-emphasis condition speaks to the possibility of regulators and practitioners engaging in deliberate efforts to place a more balanced emphasis on bias and imprecision. For example, fraud brainstorming sessions could be augmented to include discussions of other relevant sources of risk. For clients where complex estimates represent a meaningful portion of the balance sheet, this would include discussions specifically geared toward risks posed by measurement imprecision, regardless of whether the risk of bias is relatively high or low.

Optimal Strategies

As noted above, reporters in the high risk of bias condition maximize expected payoff, irrespective of the level of audit effort, by making the highest estimate possible (the signal *plus* 15). Reporters in the low risk of bias condition maximize wealth by simply making an estimate that is equal to the signal because this minimizes the expected amount of their penalty. For auditors, imprecision alone is large enough to warrant a relatively high level of audit effort, while management bias increases the magnitude of risk that auditors face.[17] Given wealth-maximizing behavior on the part of the reporter, auditors' best response in the high risk of bias condition is to exert maximum audit effort (10 on the scale from 1 to 10), while auditors' best response in the low risk of bias condition is an effort level of 8.

However, as shown in Section IV, reporters in my game do not exhibit as much upward bias as predicted based solely on the assumption of wealth-maximization. Likewise, auditors in my game do not expect reporters in the high risk of bias condition to manipulate the report upward to the fullest extent possible. Therefore, auditors' optimal response to *actual* and *expected* reporter behavior provides a more informative benchmark for normative evaluation of observed auditor behavior in light of *actual* and *expected* risk. Given either the actual levels of misreporting observed in my study, or auditors' average expectations for misreporting, auditors' best response in both the high and low risk of bias condition is to exert an effort level of 8.

[17] This corresponds to a real world setting in which an estimate's reasonable range can be many times larger than audit materiality (Christensen et al. 2012; Cannon and Bedard 2016), and regulators and practitioners recognize the need for auditors to devote a high level of effort to these accounts (e.g., Griffith et al. 2015a; Glover et al. 2017)

Appendix A provides a complete description of the parameters and a discussion of equilibrium behavior.

CHAPTER V
Results

Manipulation Checks

To confirm that auditors are attuned to the within-participants manipulation driving the risk of management bias, the post-experimental questionnaire asks auditors to recall the order in which they were paired with a reporter compensated based on the actual realization of the asset's value (i.e., the number of marbles in the container) versus the reporter's estimate. Only one participant answered this question incorrectly, and excluding that participant from my analyses does not alter the statistical conclusions reported below. [18] Additionally, auditors expect reporters compensated based on true asset value (the estimate) to guess an average of 1.06 (13.43) more marbles than the number indicated by the reporters' private signal. A repeated-measures ANOVA (untabulated) confirms that auditors expect significantly more upward bias from reporters incentivized to be biased (one-tailed $p < 0.01$), with no between-participants differences driven by emphasis (two-tailed $p = 0.25$). Thus, the manipulation of reporters' incentives results in meaningful differences in the risk of bias anticipated by auditors.

With regard to the between-participants manipulation of emphasis, the post-experimental questionnaire asks auditors to rate how much emphasis the experimental materials place on the fact that "Player A's guess" and "the imprecision of the scale" each contribute to the amount of auditors' potential loss. As shown in Table 2, responses to the question measuring perceived emphasis on bias (i.e., Player A's guess) do not differ between the condition emphasizing bias only and the condition emphasizing bias and imprecision ($t_{65} = 0.94$, two-tailed $p = 0.35$). However, responses to the question measuring perceived emphasis on imprecision are

[18] Additionally, one auditor-participant failed to complete the post-experimental questionnaire. Excluding this participant, individually, or both this participant and the participant that incorrectly recalled the order of Player A's compensation does not alter inferences from my analyses.

significantly higher for auditors in the dual-emphasis condition, relative to the bias-emphasis condition (t_{65} = 2.16, one-tailed p = 0.02). Thus, as intended, an emphasis on the risk of bias is salient in both conditions, but auditors perceive a higher emphasis on risks arising from imprecision in the dual-emphasis condition, relative to auditors in the bias-emphasis condition.

Beyond the manipulation checks, it is important to ensure that the between-participants manipulation altered the perceived *emphasis* on, and not participants' *understanding* of, measurement imprecision. The detailed instructions and multiple comprehension checks described previously provide some assurance that the emphasis manipulation should not affect participants' basic understanding of the parameters of the game. To verify that participants, particularly in the bias-emphasis condition, are aware of the implications of measurement imprecision, I turn to responses from a post-experimental question asking auditors to recall the amount of imprecision present in the measurement of the asset. All auditors correctly answered this question. Also, as shown in Table 2, Panel B, auditors in the bias-emphasis condition were aware of at least *some* emphasis being placed on measurement imprecision.[19] In sum, it appears that the between-participants manipulation was successful in manipulating emphasis, while ensuring that all participants understood the implications of imprecision for the experimental task.

Primary Findings

Audit Effort

To test the hypothesized interaction, I examine auditors' average levels of costly audit effort over the five experimental rounds comprising the high risk of bias condition and the five rounds comprising the low risk of bias condition. Results are depicted in Figure 4. Table 3

[19] Regarding my study's ability to generalize, this finding is reassuring in light of the fact that professional standards, and other aspects of the current audit environment, certainly do not ignore measurement imprecision.

reports descriptive statistics and a repeated-measures ANOVA that analyzes the risk of management bias as a within-participants factor and emphasis as a between-participants factor.[20] Unsurprisingly, I find a strong main effect of the risk of bias ($F_{1,66} = 41.02$, two-tailed $p < 0.01$), indicating that auditors exert more effort when the risk of bias is high. More importantly, I also find a significant interaction between the risk of bias and emphasis ($F_{1,66} = 4.15$, two-tailed $p = 0.05$). Confirming my hypothesis, simple effects show that auditors in the bias-emphasis condition exert less costly effort than auditors in the dual-emphasis condition when the risk of bias is low ($F_{1,66} = 2.65$, one-tailed $p = 0.05$), but not when the risk of bias is high ($F_{1,66} = 0.24$, two-tailed $p > 0.50$).[21]

The key insight from this analysis of auditors' costly effort choices is that, as predicted, an imbalanced emphasis on reporter bias, versus a more balanced emphasis on both bias an imprecision, leads to under-auditing when the risk of bias is low. This implies that environmental factors intended to increase auditors' sensitivity to the risk of management bias appear to have the effect of decreasing auditors' responsiveness to risks arising from imprecision in complex estimates. When the risk of bias is low, emphasizing bias causes auditors to "lower their guard" to a greater extent than when environmental factors place a more balanced emphasis on both bias and imprecision. Viewed in light of auditors' best response to both actual and expected reporter

[20] Average effort in each of the four experimental cells is below the optimal level, suggesting that participants in all conditionals appear willing to assume more risk than expected given predictions based solely on the intuition of economic wealth-maximization. One explanation for this finding could be fairness considerations or other common reasons that individuals deviate from purely self-interested behavior in economic games (e.g., Fehr and Gächter 2000).

[21] To control for the impact of reporters' specific estimates on chosen levels of audit effort, I also recast the data in a panel in which each auditor provides ten observations – one for each experimental round. Results from a baseline OLS regression that includes auditor fixed effects (untabulated) are inferentially consistent with the repeated measures ANOVA. Including the reporters' estimates as a control variable in the model strengthens my primary results and also indicates a significant main effect of reporters' estimates ($p < 0.01$). Controlling for the counter-balanced order in which reporters' incentives vary does not alter the impact of the other variables in the model, and the effect of order is not significant ($p > 0.50$).

behavior, this pattern of results indicates that an imbalanced emphasis on bias causes auditors to make a significantly less optimal allocation of resources when the risk of bias is low.

Also of note, solely emphasizing bias appears to confer no significant benefit when the risk of management bias is high, as auditors exert a relatively high level of effort regardless of emphasis condition. Although auditors in the bias-emphasis condition do exert slightly more effort when the risk of bias is high, the difference is not statistically significant ($F_{1,66} = 0.24$, two-tailed $p > 0.50$). Therefore, emphasizing the importance of risks related to bias *and* imprecision appears to mitigate under-auditing when management bias poses less of a threat, without diluting auditors' response to bias.

Risk Assessment

Although my hypothesis specifies the effects of the manipulated variables for audit *effort*, it follows that auditors' *assessments* of overall risk, measured prior to the start of the two sets of five experimental rounds, would exhibit the hypothesized pattern.[22] Table 4 suggests that, while the relative risk of bias has a strong main effect on auditors' risk assessments ($F_{1,66} = 46.3$, two-tailed $p < 0.01$), there is no main effect of emphasis ($F_{1,66} = 0.07$, two-tailed $p > 0.50$) and the two manipulated variables do not interact ($F_{1,66} = 1.49$, two-tailed $p = 0.23$).

This finding indicates that auditors' judgments of risk are not impaired in same way that audit effort choices appear to be, suggesting that an imbalanced emphasis on bias has a *subconscious* impact on audit effort decisions. Put differently, when the risk of bias is low, there is no meaningful difference between auditors' assessments of overall risk, and yet auditors in the

[22] This rationale reflects standard intuition that individuals' behavior in economic settings typically reflects their beliefs (e.g., Hirshleifer and Teoh 2003). However, beliefs and behavior are not always aligned (e.g., Seybert and Bloomfield 2009).

bias-emphasis condition exert significantly less audit effort. The supplemental analysis reported next adds additional insight that is helpful for interpreting this finding.

Supplemental Analysis: The Perceived Impact of Imprecision on Audit Effort

To provide evidence on the process underlying my primary findings, I examine auditors' response to a post-experimental question eliciting the extent to which auditors *perceive* that measurement imprecision influences their chosen level of audit effort. On average, auditors in both the bias-emphasis and dual-emphasis conditions acknowledge that risks related to measurement imprecision have a meaningful impact on their audit effort decisions.[23] However, if my primary findings regarding audit effort are driven by a subconscious impact of an imbalanced emphasis on bias, then auditors' *perceptions* regarding the extent to which imprecision drives audit effort are unlikely to be predictive of *actual* effort choices. Conversely, if auditors exposed to a balanced emphasis on bias and imprecision more deliberatively consider relevant risks, these auditors' *perceptions* regarding the impact of imprecision on audit effort should be associated with the level of audit effort *actually* selected.

Consistent with this reasoning, correlations shown in Table 5 indicate that although auditors in the bias-emphasis condition claim that imprecision has a large impact on their effort choices, these perceptions are uncorrelated with actual costly audit effort choices (two-tailed *p*-values > 0.50). However, in the dual-emphasis condition, auditors exhibit a significant positive

[23] On a seven-point scale anchored at 1 = "Strongly disagree" and 7 = "Strongly agree," auditor participants respond to the following statement: "The fact that the scale Player A used to estimate the number of marbles in the container was not very precise had a big impact on the Protection Level I chose." On average, auditors' responses to this question are 4.94 and 5.10 in the bias and dual-emphasis conditions, respectively. These amounts are not statistically different ($t_{65} = 0.45$, two-tailed $p > 0.50$, untabulated), and both are significantly greater than the scale's midpoint (both two-tailed *p*-values < 0.01, untabulated).

correlation between their perceptions of the impact of imprecision on effort choices and their actual effort choices (two-tailed p-values < 0.01). [24]

These supplemental results provide evidence that, despite the level of risk auditors might consciously assess, measurement imprecision plays a different role when auditors translate assessed risks into audit effort decisions in the dual-emphasis, versus bias-emphasis, condition. The correlations in Table 5 are consistent with the theoretical premise that auditors in the bias-emphasis condition rely heuristically on the relative risks of management bias, and therefore do not fully incorporate the implications of imprecision when making effort decisions. Likewise, consistent with auditors in the dual-emphasis condition engaging in more systematic processing, these auditors' *perceptions* regarding the impact of imprecision on effort reflect auditors' *actual* effort choices.

Reporter Behavior

Beyond results related to auditors, my study also offers insight into managers' financial reporting decisions under incentives to exhibit accuracy or upward bias in complex accounting estimates. Figure 5, Panel A shows the imprecise signal provided to the reporter (i.e., the weight of the marbles according to the scale) for each of the 10 experimental rounds and reporters' average guesses based on whether or not they are incentivized to exhibit bias. Figure 5, Panel B recasts reporter guesses relative to a standardized signal, thus depicting the average reporting bias exhibited in each period. Recall that the order in which reporters view the imprecise signals is held constant, but the order in which reporters are incentivized to exhibit bias is counterbalanced across experimental sessions.[25] Table 6, Panel A shows the results of a paired *t*-

[24] Untabulated z-tests confirm the correlation coefficients in Panel C are statistically different between emphasis conditions (both two-tailed p-values < 0.08).
[25] n = 10 reporters were incentivized to be biased (unbiased) in the first (second) five rounds, and n = 12 reporters were unbiased (biased) in the first (second) five rounds.

test confirming that reporters exhibit significantly more upward bias when their compensation increases with their estimate relative to when their compensation is not linked to their estimate (t_{21} = 5.86, two-tailed p < 0.01). As shown in Table 6, Panel B, for reporters incentivized to be unbiased, the average difference between estimates and the imprecise signal, although modest, is significantly greater than zero (t_{21} = 2.97, two-tailed p < 0.01).

Thus, consistent with Hales (2007) but in a context analogous to the financial reporting of complex accounting estimates, even reporters in the low risk of bias condition exhibit some degree of upward bias. Despite incentives to make accurate judgments, reporters' preferences for a favorable uncertain outcome appear to add upward bias to estimates. This result contributes to the financial reporting literature by providing some initial evidence that, even if strong internal controls perfectly control managers' economic incentives to exhibit bias, unintentional bias can still be present when managers possess directional preferences. With respect to implications for auditing, observing modest upward bias when reporters are incentivized to be impartial underscores the importance of mitigating the potential for under-auditing when the risk of bias appears to be low.

CHAPTER VI
Conclusions

Complex accounting estimates present auditors with unique challenges. Due to their subjective and uncertain nature, complex estimates are particularly susceptible to the influence of management bias. Accordingly, a number of environmental factors emphasize the impact bias has on the risk that estimates are misstated. Overall, auditing standards tend to place a spotlight on the risk of bias. Trends suggest this emphasis is likely to increase as the PCAOB and IAASB develop new standards related to the audit of complex estimates. Additionally, PCAOB inspectors make audit procedures directed toward mitigating management bias in estimates a point of emphasis in their inspections and audit firms prescribe methodology that focuses auditor attention on the risk of management bias.

Independent of the potential effects of management bias, the measurement imprecision surrounding complex estimates is important in its own right. The reasonable ranges of complex estimates often exceed several multiples of audit materiality (Christensen et al. 2012; Cannon and Bedard 2016), leasing to audit failures in complex areas that are not caused exclusively by management bias (e.g., Fang et al. 2017). Although a significant source of risk, measurement imprecision is often not emphasized in the same way as management bias. Auditing Standards 2110 and 2810, and SAS 99 – including required fraud brainstorming sessions – provide illustrative examples of environmental factors that elevate auditors' focus on intentional bias, rather than risks arising solely from measurement imprecision.

Preventing and detecting management bias is essential for successful audits, but it is important to ensure that efforts to increase auditors' awareness of bias are not accompanied by diminished auditor sensitivity to measurement imprecision. My study indicates that auditors generally respond to a high risk of bias with a high level of audit effort. However, emphasizing bias, versus bias and imprecision, causes auditors to “lower their guard” to a greater extent when management bias is less threatening but auditors still face significant risks attributable to imprecision. Consistent with theory, supplemental analysis suggests that this weakness in auditor judgment stems from auditors using the relative risk of bias as a heuristic cue when deciding how much costly effort to exert. A more balanced emphasis on both bias and imprecision not only results in a more optimal allocation of audit effort, but also provides evidence that auditors employ a more deliberative, systematic decision making approach.

Beyond implications for auditing, my findings also speak to how managers’ preferences impact their estimates of subjective amounts. Applying a framework similar to Hales (2007) to financial reporting decisions, I find that even when reporters have financial incentives to make as accurate an estimate as possible, reporters’ preferences for a high realized value results in estimates that exhibit a modest degree of upward bias. Future research could consider possible methods to mitigate bias that occurs in settings where reporters do not possess incentives to exhibit bias, but nevertheless benefit from positive realizations of the estimated amount.

Although my study does not test specific interventions that auditors might employ when considering complex estimates (e.g., Griffith et al. 2015b; Austin et al. 2016), my results nevertheless contribute evidence of, and a potential solution for, a potentially undesirable consequence of efforts intended to elevate auditors’ attention toward risks related to management bias. Giving risks arising from measurement imprecision “equal billing” with management bias in professional standards, inspections, and practitioner methodologies related to complex estimates would likely help mitigate auditors’ behavioral tendency to under-audit when the risk of bias is low. As a practical example, fraud brainstorming sessions could be augmented to include a discussion of other significant sources of risk. Thus, my findings are relevant to regulators, inspectors, and auditors in roles that influence how factors present in the audit environment shape auditors' attention toward risk.

I encourage future research that investigates ways to elevate auditors' awareness of potentially overlooked sources of risk. Regarding complex accounting estimates, I find that directing auditors' attention toward management bias can come at the expense of an adequate response to risks arising from measurement imprecision. To conduct effective audits, auditors must be attuned to all significant sources of risk, not just the risk of intentional bias.

FIGURES

Figure 1

A Framework for Considering the Technical and Social Challenges of Auditing Complex Estimates

	Technical Challenges	**Remedies**	**Social Challenges**	**Remedies**
Environmental Factors				
Estimation uncertainty	The magnitude of measurement uncertainty inhibits ability to provide positive assurance and exhibit professional skepticism (Christensen et al. 2012; Cannon and Bedard 2017; Glover et al. 2017)	Additional disclosure, alternative requirements for level of assurance, expanded audit report (Christensen et al. 2012; Glover et al. 2017)	Supplemental disclosures reduce likelihood of audit adjustments (Griffin 2014) Uncertainty and auditor-client socials bonds prompt "the benefit of the doubt" (Kachelmeier and Van Landuyt 2017)	Increase the role of non-client facing personnel (Kachelmeier and Van Landuyt 2017)
Regulatory environment	PCAOB inspections shift focus from audit risk to "inspection risk" (Glover et al. 2016)	Clarify expectations and increase expertise (Glover et al. 2016)	The application of current standards results in inconsistent adjustment decisions (Emett et al. 2016) A judgment quality, versus procedural, focus by inspectors improves audit judgments and skepticism (Tegeler 2017)	Redefine misstatements as the difference between the reporter value and auditors' best estimate (Emett et al. 2016) Inspections should place more focus on judgment quality, rather than procedures performed (Tegeler 2017)
Legal environment				
Auditor-client relationship	Management sometimes lacks adequate valuation knowledge or expertise (Glover et al. 2017) Auditors find it difficult to persuade management to book adjustments (Cannon and Bedard 2017).	Utilize specialists to convey to client the strength of evidence gathered (Cannon and Bedard 2017)	See *Estimation uncertainty* above	See *Estimation uncertainty* above

Figure 1, cont.

	Technical Challenges	Remedies	Social Challenges	Remedies
Auditor-specialist relationship	Uncertainty leads to auditor disagreement with valuation specialists (Cannon and Bedard 2017) Coordination challenges and lack of common vocabulary limits value provided by specialists (Griffith et al. 2015a) Third-party pricing services often do not share proprietary information relevant to auditors' evaluation of estimates (Glover et al. 2017)	Regulators could work to foster cooperation between third-parties and auditors (Glover et al. 2017)	Use of specialists can trigger defensive behavior from auditors, reducing the value of specialists' contributions to the audit (Griffith 2016a) Auditors do not fully appreciate entirety of information conveyed by specialists unless motivated to closely scrutinize estimates (Griffith 2016b) Specialists perform better when they feel they have psychological ownership over issues (Bauer et al. 2017) Auditors over rely on client-hired specialists if firm tone-at-the-top performance goals (Pyzoha et al. 2016) Quantification in reports from client-hired specialists decreases attention to subjective valuation inputs (Joe et al. 2017)	More explicit guidance for incorporating specialists' work. More integration between specialists and audit teams (Griffith 2016a) Training and decision aids to motivate sensitivity to risk (Griffith 2016b) Increase auditors', including specialists', psychological ownership over tasks (Bauer et al. 2017) Promote (restrict) emphasis on audit quality (performance goals) (Pyzoha et al. 2016) Regulators may need to reconsider how audit tasks are structured to enhance attention to subjective areas (Joe et al. 2017)
Task Factors				
Task difficulty	See *Estimation uncertainty* above Nonfinancial estimates are especially challenging (Glover et al 2017)	See *Estimation uncertainty* above		

Figure 1, cont.

	Technical Challenges	Remedies	Social Challenges	Remedies
Task structure	Verification approach to estimates results in auditors overlying on managements'' assumptions (Griffith et al. 2015a)	Utilize an evaluation approach (Griffith et al. 2015a). Reconsider merits of using managements' assumptions to develop an independent estimate (Glover et al. 2017)	Documentation instructions promoting high-level construals improve auditor judgments, actions, and skepticism (Rasso 2015) Audit guidance framing affects auditors' judgments (Austin et al. 2016; Cohen et al. 2016; Maksymov et al. 2017)	Documentation instructions should prompt auditors to "think broadly" about audit evidence. Focus on "why" vs. "how" (Rasso 2015) Guidance should emphasize attention to contradictory evidence or take a "negative" frame (Austin et al. 2016; Cohen et al. 2016; Maksymov et al. 2017)
Management bias	Estimates are susceptible to management bias (Bratten et al. 2013; Griffith et al. 2015a)	Auditors should be attentive to management bias (Bratten et al. 2013; Griffith et al. 2015a)	Auditors perceive more bias when portfolios have several small overstatements or overstatements represent a large percentage of book value (Emett et al. 2016) An imbalanced emphasis on bias decreases auditor sensitivity to measurement imprecision (Van Landuyt 2017)	Environmental factors should place a more balanced emphasis on bias and imprecision (Van Landuyt 2017)
Auditor-Specific Factors				
Auditor knowledge and expertise	See *Estimation uncertainty* above	See *Estimation uncertainty* above		
Application of professional skepticism	See *Estimation uncertainty* above	See *Estimation uncertainty* above	Deliberative, versus implemental, mindsets improve judgments and skepticism (Griffith et al. 2015b) See *Task structure* above	Practitioners could employ interventions to promote deliberative mindsets (Griffith et al. 2015b).
Cognitive limitations	See *Estimation uncertainty* above	See *Estimation uncertainty* above		

Figure 2
Manipulation of the Risk of Management Bias

Panel A: Reporters' additional compensation in the **high** risk of bias condition

	Lowest Possible Estimate (Signal – 15)	Highest Possible Estimate (Signal + 15)
Reporter's Additional Compensation:	$0 *increases by $0.50 per marble guessed*	$15

Panel B: Reporters' additional compensation in the **low** risk of bias condition

	Fewest Possible Marbles in the Container (Signal – 15)	Most Possible Marbles (Signal + 15)
Reporter's Additional Compensation:	$0 *increases by $0.50 per marble in the container*	$15

Figure 3
Experimental Timeline and Manipulation of Risk Emphasis

Panel A: Experimental timeline

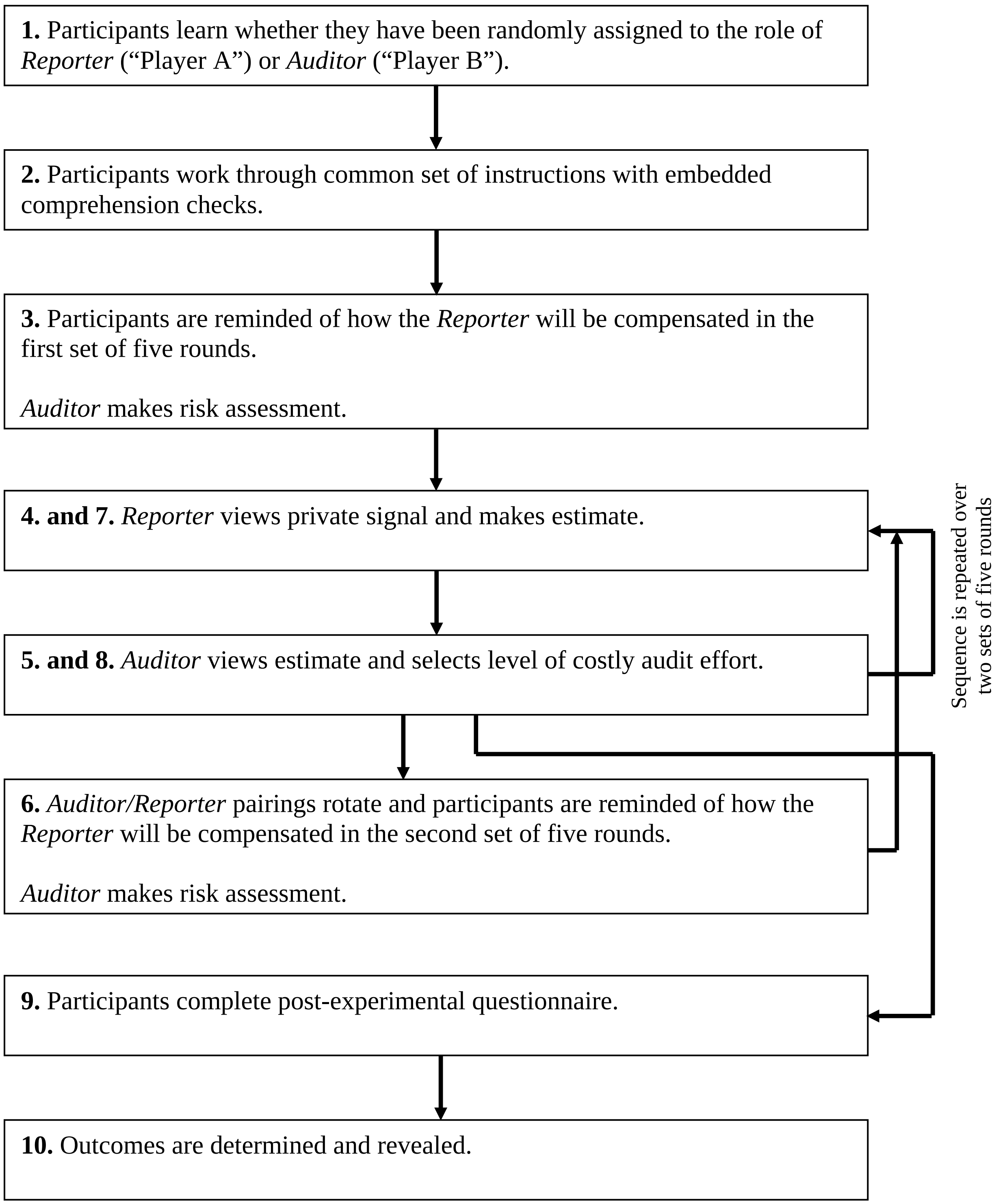


Figure 3, cont.

Panel B: Wording used to convey to auditors an emphasis on management bias only

At **1.** (refer to Panel A)

> You are about to learn that in some rounds of the task, you will be paired with a Player A who has incentives to ignore the information that is available to him or her and, as a result, make choices that are likely to increase the chances that you get a low payoff. During other rounds, you will be paired with a Player A who does not have such incentives.

At **3.***

> In this <u>first set of five rounds</u> the additional payment to Player A increases as the actual number of marbles in the container increases.
>
> ***Player A's Incentives***
>
> Because Player A's guess does not impact Player A's additional payment, but Player A's Loss is based on the number of marbles by which his or her guess is "off", Player A's incentives are best served when he or she guesses a number that is close to the measurement provided by the scale.

At **6.***

> In this <u>second set of five rounds</u> the additional payment to Player A increases as the number of marbles Player A guesses increases.
>
> ***Player A's Incentives***
>
> Because Player A can get a higher payment by guessing more marbles (and the amount of this additional payment is more than Player A's possible Loss), Player A has an incentive to always guess more marbles than indicated by the measurement provided by the scale.

*The order in which participants view the wording conveyed in **3.** and **6.** is counterbalanced between experimental sessions to match the counterbalanced order of the within-participant manipulation of management bias.

Figure 3, cont.

Panel C: Wording used to convey to auditors an emphasis on management bias and measurement imprecision

At **1.** (refer to Panel A)

> You are about to learn that in some rounds of the task, you will be paired with a Player A who has incentives to ignore the information that is available to him or her and, as a result, make choices that are likely to increase the chances that you get a low payoff. During other rounds, you will be paired with a Player A who does not have such incentives.
>
> You will also learn that the information available to Player A is not very precise. Thus, regardless of Player A's incentives, the result of Player A's decisions in the experimental task might contribute to the possibility that you get a low payoff.

At **3.***

> In this <u>first set of five rounds</u> the additional payment to Player A increases as the actual number of marbles in the container increases.
>
> ***Player A's Incentives***
> Because Player A's guess does not impact Player A's additional payment, but Player A's Loss is based on the number of marbles by which his or her guess is "off", Player A's incentives are best served when he or she guesses a number that is close to the measurement provided by the scale.
>
> ***Imprecision of the Scale***
> The fact that the scale used to weigh the marbles is imprecise contributes to the possibility that the measurement viewed by Player A, and ultimately his or her guess, might not be very close to the actual number of marbles in the container.

At **6.***

> In this <u>second set of five rounds</u> the additional payment to Player A increases as the number of marbles Player A guesses increases.
>
> ***Player A's Incentives***
> Because Player A can get a higher payment by guessing more marbles (and the amount of this additional payment is more than Player A's possible Loss), Player A has an incentive to always guess more marbles than indicated by the measurement provided by the scale.
>
> ***Imprecision of the Scale***
> The fact that the scale used to weigh the marbles is imprecise contributes to the possibility that the measurement viewed by Player A, and ultimately his or her guess, might not be very close to the actual number of marbles in the container.

*The order in which participants view the wording conveyed in **3.** and **6.** is counterbalanced between experimental sessions to match the counterbalanced order of the within-participant manipulation of management bias.

Figure 4
Average Level of Costly Effort Selected by Auditors

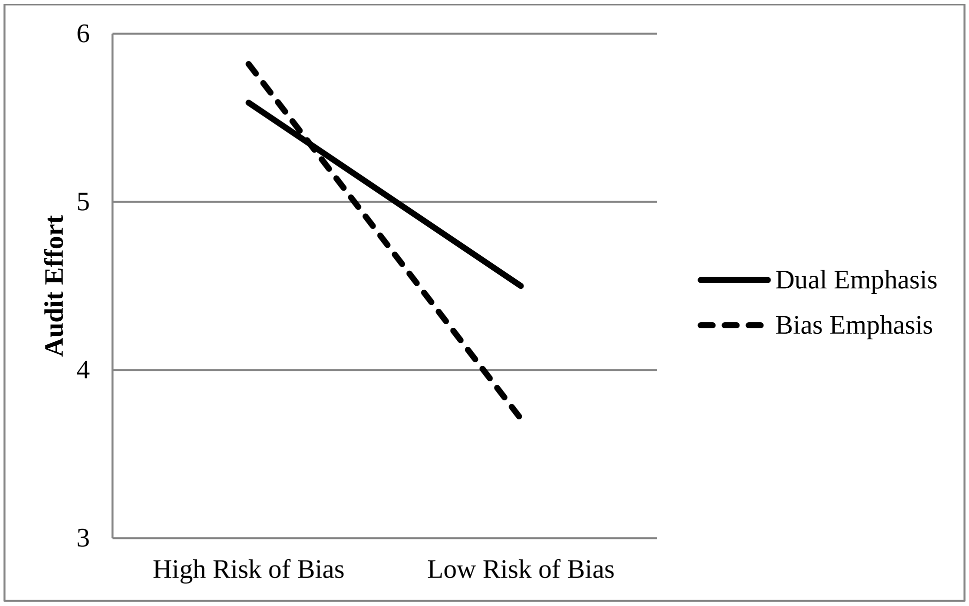
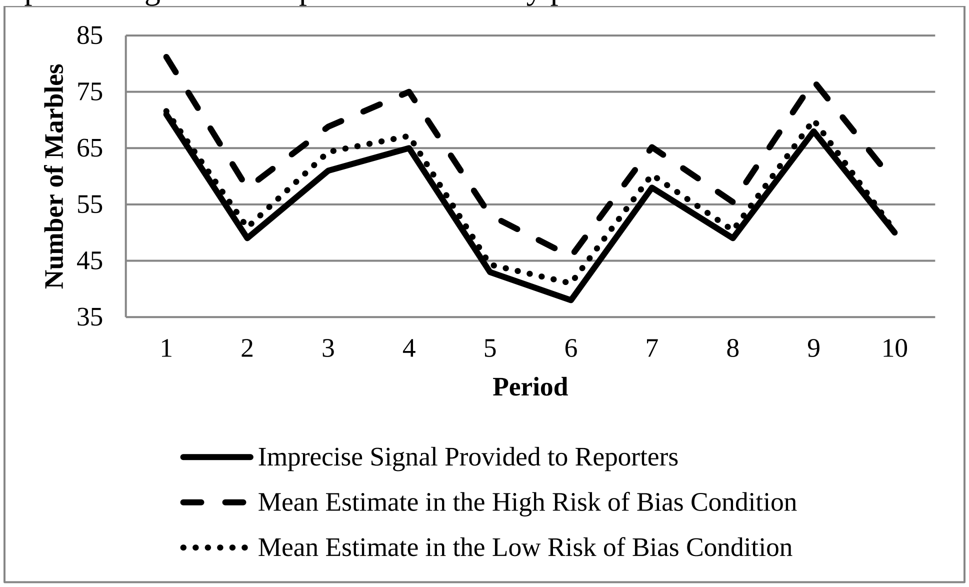
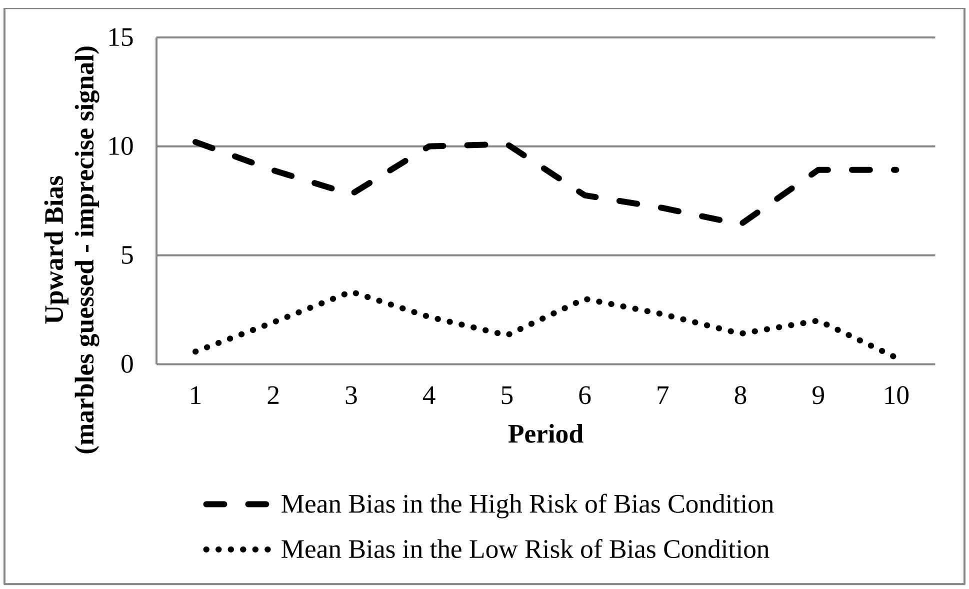


Figure 5
Reporter Estimates

Panel A: Imprecise signals and reporter estimates by period



Panel B: Reporter bias by period (mean estimates relative to a standardized signal)



TABLES
Table 1
Probabilities Associated with Chosen Level of Audit Effort

Panel A: The impact of audit effort on the probability the **auditor** incurs a penalty

Audit Effort	P(*Auditor Penalty)*
1	0.95
2	0.80
3	0.65
4	0.55
5	0.45
6	0.35
7	0.25
8	0.15
9	0.10
10	0.05

Panel B: The impact of audit effort on the probability the **reporter** incurs a penalty

Audit Effort	P(*Reporter Penalty)*
1	0.05
2	0.10
3	0.15
4	0.25
5	0.35
6	0.45
7	0.55
8	0.65
9	0.80
10	0.95

Table 2
Manipulation Check: Emphasis on Bias versus Emphasis on Bias and Imprecision

Panel A: Auditors' mean (std. dev.) response to the post-experimental question, "In general, how much emphasis did the experimental materials place on the fact that Player A's guess contributed to the amount of your potential loss?"

	Bias Emphasis	Dual Emphasis	df	*t*-statistic	*p*-value
	5.69 (1.09)	5.94 (1.00)	65	0.94	0.35

Panel B: Auditors' mean (std. dev.) response to the post-experimental question, "In general, how much emphasis did the experimental materials place on the fact that the imprecision of the scale contributed to the amount of your potential loss?"

	Bias Emphasis	Dual Emphasis	df	*t*-statistic	*p*-value
	4.47 (1.75)	5.32 (1.42)	65	2.16	**0.02**

Responses measured on a seven-point scale ranging from 1 = "not emphasized" to 7 = "heavily emphasized." Reported *p*-values are two-tailed with the exception of directional predictions which are one-tailed, as indicated by **boldface**.

Table 3
Costly Audit Effort

Panel A: Mean (std. dev.) level of costly effort selected by auditors

	High Risk of Bias	Low Risk of Bias
Dual Emphasis	5.59	4.50
n = 31	(1.96)	(2.34)
Bias Emphasis	5.82	3.71
n = 37	(1.86)	(1.64)

Panel B: Repeated measures analysis of variance

Source	df	M.S.	F-Statistic	*p*-value
Between-Participants				
Emphasis	1	2.64	0.48	0.49
Error	66	5.48		
Within-Participants				
Risk of Bias	1	86.28	41.02	< 0.01
Risk of Bias × Emphasis	1	8.74	4.15	0.05
Error	66	2.10		

Panel C: Simple effect of emphasis given the risk of reporter

Effect of emphasis given:	F-Statistic	*p*-value
High Risk of Bias	0.24	0.62
Low Risk of Bias	2.65	**0.05**

The within-participants dependent variables used in the analysis are auditors' average chosen protection level, ranging from 1 to 10, over the five rounds comprising the high risk of bias condition and auditors' average chosen protection level over the five comprising the low risk of bias condition.
Risk of bias is manipulated within-participants by varying reporters' additional compensation as shown in Figure 1.
Emphasis is manipulated between-participants as shown in Figure 2.
Reported *p*-values are two-tailed with the exception of directional predictions which are one-tailed, as indicated by **boldface**.

Table 4
Auditors' Risk Assessments

Panel A: Auditors' mean (std. dev.) risk assessments

	High Risk of Bias	Low Risk of Bias
Dual Emphasis	6.90	5.10
n = 31	(2.27)	(2.39)
Bias Emphasis	7.43	4.84
n = 37	(2.79)	(2.50)

Panel B: Repeated measures analysis of variance

Source	df	M.S.	F-Statistic	*p*-value
Between-Participants				
Emphasis	1	0.62	0.07	0.80
Error	66	9.07		
Within-Participants				
Risk of Bias	1	163.36	46.30	< 0.01
Risk of Bias × Emphasis	1	5.24	1.49	0.23
Error	66	2.10		

The within-participants dependent variables used in the analysis are auditors' responses to the question "How concerned are you about the possibility that you will incur the Loss of up to $15 and, as a result, get a low payment for this set of five rounds?" Responses were measured prior to start of each set of five rounds, using an 11-point Likert scale anchored at 0 = "Not at all concerned" and 10 = "Very concerned."
Risk of bias is manipulated within-participants by varying reporters' additional compensation as shown in Figure 1.
Emphasis is manipulated between-participants as shown in Figure 2.
Reported *p*-values are two-tailed.

Table 5
Supplemental Analysis: Evidence of Systematic and Heuristic Processing

Pearson correlations between auditors' *perceived* impact of measurement imprecision on audit effort decisions and auditors' *actual* level of audit effort.

	Actual Audit Effort, High Risk of Bias	*Actual* Audit Effort, Low Risk of Bias
Perceived Impact of Imprecision on Audit Effort, Bias Emphasis	0.06 $p = 0.74$	0.09 $p = 0.62$
Perceived Impact of Imprecision on Audit Effort, Dual Emphasis	0.48 $p < 0.01$	0.49 $p < 0.01$

The variable "*Actual* Audit Effort" is auditors' average chosen protection level, ranging from 1 to 10, over the five rounds comprising the high risk of bias condition and auditors' average chosen protection level over the five comprising the low risk of bias condition.
The variable "*Perceived* Impact of Imprecision on Audit Effort" represents auditors' responses, measured on a seven-point scale anchored at 1 = "Strongly disagree" and 7 = "Strongly agree," to the following statement: "The fact that the scale Player A used to estimate the number of marbles in the container was not very precise had a big impact on the Protection Level I chose."
Risk of bias is manipulated within-participants by varying reporters' additional compensation as shown in Figure 1.
Emphasis is manipulated between-participants as shown in Figure 2.
Reported *p*-values are two-tailed.

Table 6
Reporter Estimates

Panel A: Mean (std. dev.) difference between reporter estimates and the imprecise signal

	High Risk of Bias	Low Risk of Bias	df	*t*-statistic	*p*-value
Upward bias	8.55 (5.39)	1.84 (2.90)	21	5.86	< 0.01

Panel B: One-sample *t*-test of the null hypothesis that the mean upward bias exhibited by reporters in the low risk of bias condition is equal to zero

	Low Risk of Bias	df	*t*-statistic	*p*-value
Upward bias	1.84 (2.90)	21	2.97	< 0.01

Reporters form an estimate based on observation of a randomly determined, imprecise signal. Estimates are constrained to be equal to the imprecise signal plus or minus 15.
Risk of bias is manipulated within-participants by varying reporters' additional compensation as shown in Figure 1.
Reported *p*-values are two-tailed.

APPENDICES
Appendix A
Parameters and Equilibrium for Audit Game

V = true asset value (unknown)
S = reporter's private signal = $V + e$, $e \in U\{-15, 15\}$
G = reporter's estimate, $G \in \{S - 15, S - 14, \ldots, S + 14, S + 15)$
Reporter Penalty = f(|*G* – *V*|):
    if $|G - V| \leq 5$, *Reporter Penalty* = \$0
    if $5 < |G - V| < 10$, *Reporter Penalty* = \$|5 – (|*G* – *V*|)|
    if $|G - V| \geq 10$, *Reporter Penalty* = \$5
P(*Reporter Penalty*) = see Table 1 Panel B
Auditor Penalty = f(|*G* – *V*|):
    if $|G - V| \leq 5$, *Auditor Penalty* = \$0
    if $5 < |G - V| < 15$, *Auditor Penalty* = \$|*G* – *V*|
    if $|G - V| \geq 15$, *Auditor Penalty* = \$15
P(*Auditor Penalty*) = see Table 1 Panel A
Audit Effort ∈ {1, 2, … , 9, 10}
c(*Audit Effort*) = *Audit Effort* × \$0.50

Reporter's payoff (high risk of bias condition)
    = \$5 + \$0.5(*G* + 15 – *S*) – [P(*Reporter Penalty*) × *Reporter Penalty*]

Reporter's payoff (low risk of bias condition)
    = \$5 + \$0.5(*S* + 15 – *V*) – [P(*Reporter Penalty*) × *Reporter Penalty*]

Auditor's payoff (in all conditions)
    = \$20 – c(*Audit Effort*) – [P(*Auditor Penalty*) × *Auditor Penalty*]

<u>In the high risk of bias condition</u>, the reporter faces a trade-off between the benefit of increasing the second term in his/her payoff function (by choosing a high *G*) and the cost of increasing the expected penalty (which increases in expectation as *G* deviates from *S*). The marginal benefit of choosing a high *G* is greater than the marginal cost imposed by a larger expected penalty (regardless of the likelihood of penalty as determined by audit effort), thus a wealth-maximizing reporter will choose $G^* = S + 15$ (the highest possible *G*).

<u>In the low risk of bias condition</u>, the reporter maximizes expected utility by minimizing the expected amount of the *Reporter Penalty*. Because *S* is equal to *V*, in expectation, the expected amount of the *Reporter Penalty* is \$0 when the reporter chooses $G^* = S$.

The auditor faces a trade-off between the cost of *Audit Effort* and the corresponding benefit provided by a lower probability of incurring the *Auditor Penalty*.

At equilibrium, in the high risk of bias condition, the expected amount of the *Auditor Penalty* is:

$f(|G^* - V|) = f(|S + 15 – V|) = f(|V + e + 15 – V|) = f(|e + 15|)$

⇨ if $|e + 15| \leq 5$, *Auditor Penalty* = \$0
if $5 < |e + 15| < 15$, *Auditor Penalty* = $\$|e + 15|$
if $|e + 15| \geq 15$, *Auditor Penalty* = \$15

⇨ E[*Auditor Penalty*]
= [P($-15 \leq e \leq -10$) × \$0] + [P($-9 \leq e \leq 0$) × \$E[$|e + 15|$, given $-9 \leq e \leq 0$]]
+ [P($1 \leq e \leq 15$) × \$15]
= [(6/31) × \$0] + [(10/31) × \$|-4.5 + 15|] + [(15/31) × \$15]
= \$0 + \$3.39 + \$7.26
= \$10.65

Evaluating the auditor's payoff function using an expected *Auditor Penalty* of \$10.65 shows that, given the possible levels of *Auditor Effort* and associated c(*Audit Effort*) and P(*Auditor Penalty*), the auditor, at equilibrium, maximizes expected payoff by choosing *Auditor Effort** = 10.

Recalculating the above based on actual reporter behavior and auditors' average expectations of reporter behavior (G = 8.55 and G = 13.43, respectively) yields expected *Auditor Penalties* of \$8.00 and \$9.97, respectively. Evaluating the auditor's payoff function using either of these expected *Auditor Penalties* shows that the auditor, in response to actual or expected reporter behavior, maximizes expected payoff by choosing *Auditor Effort** = 8.

At equilibrium, in the low risk of bias condition, the expected amount of the *Auditor Penalty* is:

$f(|G^* - V|) = f(|S – V|) = f(|V + e – V|) = f(|e|)$

⇨ if $|e| \leq 5$, *Auditor Penalty* = \$0
if $5 < |e| \leq 15$, *Auditor Penalty* = $\$|e|$
if $|e| \geq 15$, *Auditor Penalty* = \$15

⇨ E[*Auditor Penalty*]
= [P($-5 \leq e \leq 5$) × \$0] + [P($-15 \leq e < -5$) × \$E[$|e|$, given $-15 \leq e < -5$]]
+ [P($5 < e \leq 15$) × \$E[$|e|$, given $5 < e \leq 15$)]]
= [(11/31) × \$0] + [(10/31) × \$|-10.5|] + [(10/31) × \$|10.5|]
= \$0 + \$3.39 + \$3.39
= \$6.78

Evaluating the auditor's payoff function using an expected *Auditor Penalty* of $6.78 shows that, given the possible levels of *Auditor Effort* and associated c(*Audit Effort*) and P(*Auditor Penalty*), the auditor maximizes expected payoff by choosing *Auditor Effort** = 8.

Recalculating the above based on actual reporter behavior and auditors' average expectations of reporter behavior (*G* = 1.84 and *G* = 1.06, respectively) yields expected *Auditor Penalties* of $6.96 and $6.94, respectively. Evaluating the auditor's payoff function using either of these expected *Auditor Penalties* shows that the auditor, in response to actual or expected reporter behavior, maximizes expected payoff by choosing *Auditor Effort** = 8.

Appendix B
Participant Materials

Note: Instructions provided to participants appear in Arial font. Explanatory headings appear in all capitals using bolded and underlined Times New Roman font. Explanatory commentary not appearing to participants appears in italicized Times New Roman font and is set off by brackets.

GENERAL INSTRUCTIONS

[Read aloud by the experimental administrator]
Welcome and thank you for participating in this study!

The experimental session will take about 60 minutes. Just for showing up today, you will receive $5, and you have the possibility to earn considerably more. All compensation described from this point forward is *in addition* to the $5 "show up fee."

There should be no talking during the session. Please refrain from any communication with your fellow participants. Also, please do not discuss the experiment with other students who might be participating in future sessions.

The experiment will be conducted exactly in the manner described in these instructions, with no deception of any form. Although much of this experiment has been programmed on a computer, the computer program accurately reflects the instructions.

A hard copy of the instructions is provided for your reference, but all the information that you will need to complete the experiment will be given through the computer program.

You may now press begin on your computer screen and follow the on screen prompts.

[Begin instructions and comprehension check questions administered through z-Tree. Individual screens presented on z-Tree are separated by "--". This first screen contains wording that (along with PLAYER B's RISK ASSESSMENT, shown below) is part of the between-participants manipulation of "Bias Emphasis" versus "Dual Emphasis."]
Role Assignment
In today's study, you will complete several rounds of an activity that involves input from you and another participant in this session.

[Player A]
You will assume the role of **Player A**, and will be paired with another participant who is in the role of Player B.

The outcome of the experimental task (and, as a result, the amount of your payment today) depends not only on decisions you make, but also on decisions made by Player B, and luck. Therefore, it is important for you to pay attention to ***all*** of the instructions (not just the instructions that specifically relate to Player A).

[Player B, Bias Emphasis Condition]
You will assume the role of **Player B**, and will be paired with another participant who is in the role of Player A.

The outcome of the experimental task (and, as a result, the amount of your payment today) depends not only on decisions you make, but also on decisions made by Player A, and luck. Therefore, it is important for you to pay attention to ***all*** of the instructions (not just the instructions that specifically relate to Player B).

In fact, you are about to learn that in some rounds of the task, you will be paired with a Player A who has incentives to ignore the information that is available to him or her and, as a result, make choices that are likely to increase the chances that you get a low payoff. During other rounds, you will be paired with a Player A who does not have such incentives.

[Player B, Dual Emphasis Condition]
You will assume the role of **Player B**, and will be paired with another participant who is in the role of Player A.

The outcome of the experimental task (and, as a result, the amount of your payment today) depends not only on decisions you make, but also on decisions made by Player A, and luck. Therefore, it is important for you to pay attention to ***all*** of the instructions (not just the instructions that specifically relate to Player B).

In fact, you are about to learn that in some rounds of the task, you will be paired with a Player A who has incentives to ignore the information that is available to him or her and, as a result, make choices that are likely to increase the chances that you get a lower payoff. During other rounds, you will be paired with a Player A who does not have such incentives.

You will also learn that the information available to Player A is not very precise. Thus, regardless of Player A's incentives, the result of Player A's decisions in the experimental task might contribute to the possibility that you get a low payoff.

--

Overview
As mentioned on the previous screen, the experimental task involves decisions made in pairs with one Player A and one Player B. Each pair will repeat the activity described in these instructions for five rounds. Each individual round is independent from the other rounds, meaning that potential gains and losses do not carry over from round to round.

Once you have finished the five rounds, you will be anonymously paired with a *different* person in this session for another five rounds. However, you will remain assigned to the same role (either Player A or Player B) for both sets of five rounds.

Besides being paired with a different person for the second set of five rounds, the way in which Player A is compensated will also change in the second set of five rounds. The way Player B's compensation is determined will remain constant throughout the experiment. The instructions that follow will describe this in detail.

The outcomes of one round from the first set of five rounds and one round from the second set of five rounds will be randomly selected to determine your payment.

To summarize, you will complete ten rounds of the task that is about to be described: five rounds anonymously paired with one person, and five rounds anonymously paired with a different person. In addition to new pairings, the method used to determine Player A's payment will differ between the first and second set of five rounds. However, you will remain assigned to the same role (either Player A or Player B) throughout the entire experiment.

--

Player A's task
Imagine a large container filled with marbles. (The experiment is programmed on a computer, but thinking about the task in these terms will help you to understand the instructions.)

Player A's job is to guess how many marbles are in the container.

The container is sealed shut, so it is impossible to just count the marbles. Instead, to get an idea of how many marbles are in the container, Player A must use a scale to weigh the container. Assume that the container, itself, is weightless, and each marble weighs one ounce. Thus, for example, if the container (with marbles in it) weighs exactly 100 ounces, there are 100 marbles in the container.

Unfortunately, the scale used to weigh the marbles is not precise. When Player A weighs the marbles, the scale provides a measurement that is equal to the sum of the actual weight (which is equivalent to the actual number of marbles) and a random number that can be anything from -15 to +15. Thus, the measurement provided by the scale is within 15 ounces of the actual weight, but Player A will not know exactly how close the measurement is, or whether the measurement is higher or lower than the actual weight of the marbles.

For example, if the actual number of marbles in the container is 40, the measurement provided by the scale could be anything between:

the lowest possible measurement

the highest possible measurement

(These instructions will contain several questions that you must answer correctly to continue.)

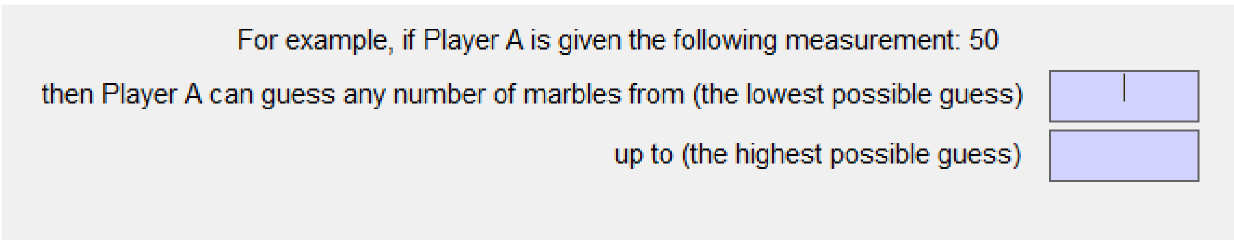
[Incorrect answers to comprehension check questions result in participants viewing remedial information before being given another attempt to answer the question(s). Participants must answer each comprehension check question correctly before they can continue with the instructions.]

--

Player A's task, continued

Once Player A has viewed the measurement provided by the scale, Player A makes a guess about the number of marbles in the container.

Because the measurement given by the scale is within 15 ounces of the container's actual weight, Player A can guess any number of marbles between the measurement given by the scale *minus* 15 and the measurement given by the scale *plus* 15.



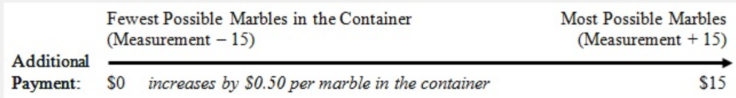
--

How Player A will be compensated **<u>in the first set of five rounds:</u>** *[The order in which the instructions present Player A's payment scheme is counter balanced to match experimental sessions where Player A is incentivized to exhibit bias in the first set of five rounds and is incentivized to be unbiased in the second set of five rounds]*

For making the guess, Player A will receive fixed pay of $5.00. Player A will also receive some additional compensation ranging between $0 and $15, as described below.

In the **first** set of five rounds, Player A's additional compensation is based on the *actual number of marbles in the container*. The *higher* the number marbles that are in the container, the more additional payment Player A will receive. This additional payment is **not** affected by how many marbles Player A *guesses* are in the container.

Specifically, if the actual number of marbles in the container is equal to the measurement minus 15 (the lowest possible number of marbles in the container given the measurement observed), Player A's additional payment will be $0. For each marble above this amount, Player A will receive an additional $0.50. This is illustrated by the following diagram:



For example: Beyond the $5 fixed pay, if the measurement provided by the scale is **50**, and

The actual number of marbles is **35** (the lowest possible number of marbles given a measurement of 50), Player A will receive additional pay of $ ______

The actual number of marbles is **50**, Player A will receive additional pay of $ ______

The actual number of marbles is **65** (the highest possible number of marbles given a measurement of 50), Player A will receive additional pay of $ ______

True or false:

For the second set of five rounds, the amount of the additional payment depends on the number of marbles guessed by Player A. ○ true ○ false

For the second set of five rounds, the amount of the additional payment depends on the actual number of marbles in the container. ○ true ○ false

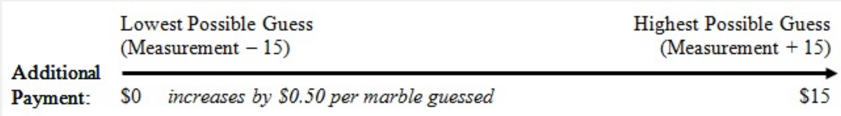
--

How Player A will be compensated **<u>in the second set of five rounds:</u>**

As before, Player A will receive fixed pay of $5.00 for making the guess. However, Player A's additional compensation (which still ranges from $0 to $15) is determined in a different manner, as described below.

In the **second** set of five rounds, Player A's additional compensation is based on the *guess* that Player A makes. The *higher* Player A's guess, the more additional payment Player A will receive. This additional payment is **not** affected by how many marbles are *actually* in the container.

Specifically, if Player A's guess is equal to the measurement minus 15 (the lowest possible guess Player A can make), Player A's additional payment will be $0. For each marble Player A guesses above this lowest possible guess, Player A will receive an additional $0.50. This is illustrated by the following diagram:



For example: Beyond the $5 fixed pay, if the measurement provided by the scale is **50**, and

Player A guesses **35** (the lowest possible guess given a measurement of 50), Player A will receive additional pay of $

Player A guesses **50**, Player A will receive additional pay of $

Player A guesses **65** (the highest possible guess given a measurement of 50), Player A will receive additional pay of $

True or false:

For the first set of five rounds, the amount of the additional payment depends on the number of marbles guessed by Player A. ◯ true ◯ false

For the first set of five rounds, the amount of the additional payment depends on the actual number of marbles in the container. ◯ true ◯ false

--

Summary of Player A's Compensation

To summarize, Player A receives $5 and some additional payment.

<u>In the first set of five rounds</u>, the additional payment increases as the number of marbles in the container increases.

<u>In the second set of five rounds</u>, the additional payment increases as the number of marbles that Player A guesses increases.

Additionally, depending on how far Player A's guess is "off" from the *actual* number of marbles in the container, Player A *might* lose up to $5. How this loss ("Player A's Loss") is determined will be described later in these instructions. Next, let's take a look at Player B's Task and Compensation.

--

Player B's Task and Possible Loss for Player B
Player B is given fixed pay of $20.

The accuracy of Player A's guess determines the amount of a possible loss that Player B might incur.

Specifically, the *absolute value* of the difference between Player A's guess and the actual number of marbles in the container determines the ***amount***, in U.S. Dollars, of a Loss that *could* apply to Player B ("Player B's Loss").

However, if Player A's guess is "off" by 5 marbles or less, Player B's Loss is $0. Also, even if Player A's guess is "off" by more than 15 marbles, Player B's Loss will not exceed $15. Thus, Player B's Loss can be anything between $0 and $15.

In simple terms, the number of marbles that Player A's guess is "off," equals to the Dollar amount of Player B's Loss. For example if Player A's guess is "off" by 7 marbles in either direction, Player B faces a potential Loss of $7. However, the amount of the possible Loss for Player B will never be more than $15 (even if Player A's guess is "off" by more than 15). And, if Player A's guess is "off" by 5 marbles or less, the amount of Player B's Loss will be $0.

The key point to remember is that the ***closer*** Player A's guess is to the actual number of marbles in the container, the lower the amount of the potential Loss for Player B will be.

For example:

If Player A guessed 75 and there were actually 65 marbles in the container, what would be the ***amount*** of the potential Loss for Player B? $

If Player A guessed 25 and there were actually 30 marbles in the container, what would be the ***amount*** of the potential Loss for Player B? $

If Player A guessed 50 and there were actually 25 marbles in the container, what would be the ***amount*** of the potential Loss for Player B? $

--

Player B's Task and Possible Loss for Player B, continued
After viewing Player A's guess, but **not** the measurement provided by the scale, Player B selects a Protection Level that ranges from 1 to 10.

The Protection Level determines the ***likelihood*** that Player B will incur a Loss. Higher levels of Protection are more costly to Player B, but reduce the probability of Player B's Loss.

Specifically, Player B must pay $0.50 for each incremental level of protection. That is, Player B's cost is equal to the Protection Level (1 through 10) *times* $0.50.

For example:

If Player B chooses Protection Level 1 (the lowest possible level of Protection), Player B must pay $

If Player B chooses Protection Level 5, Player B must pay $

If Player B chooses Protection Level 10 (the highest possible level of Protection), Player B must pay $

As the Protection Level *increases*, the likelihood of Player B's Loss *decreases*. See the table below (also provided in hard copy for your reference):

Protection Level	Player B's cost	Likelihood of Player B's Loss
1	$0.50	95%
2	$1.00	80%
3	$1.50	65%
4	$2.00	55%
5	$2.50	45%
6	$3.00	35%
7	$3.50	25%
8	$4.00	15%
9	$4.50	10%
10	$5.00	5%

For example:

If Player B selects Protection Level 1, what is the % chance of Player B incurring a Loss based on the absolute value of the difference between Player A's guess and the actual number of marbles ("Player B's Loss")?

If Player B selects Protection Level 5, what is the % chance of Player B incurring Player B's Loss?

If Player B selects Protection Level 10, what is the % chance of Player B incurring Player B's Loss?

As the Protection Level chosen by Player B ***increases***:

the **cost** to Player B ○ increases ○ decreases

the **likelihood** that Player B incurs a Loss ○ increases ○ decreases

--

How Player B's choice of Protection Level also impacts Player A

Just as Player A's guess influences the amount of the Loss that Player B might incur, the level of Protection chosen by Player B also has an effect on Player A's payment.

Recall that Player A receives fixed pay of $5 and additional pay that can range from $0 to $15 based on either the actual number of marbles in the container (during the first five rounds), or Player A's guess (during the second five rounds).

In addition to these amounts, Player A might also incur a Loss that ranges from $0 to $5 ("Player A's Loss"). How the ***amount*** of Player A's Loss is determined will be described on the next screen.

The higher the Protection Level chosen by Player B, the higher the ***likelihood*** that Player A will incur Player A's Loss. Player A's Loss is completely separate from Player B's Loss. The possible likelihoods of Player A's Loss are shown in the table below (also provided in hard copy):

Protection Level (Selected by Player B)	Likelihood of Player A's Loss
1	5%
2	10%
3	15%
4	25%
5	35%
6	45%
7	55%
8	65%
9	80%
10	95%

For example:

If Player B selects Protection Level 3, what is the % chance that Player A incurrs Player A's Loss?

If Player B selects Protection Level 7, what is the % chance that Player A incurrs Player A's Loss?

As the protection level chosen by Player B ***increases***, the **likelihood** that Player A incurs a Loss
- increases
- decreases

--

How Player B's choice of Protection Level also impacts Player A, continued

The ***amount*** of Player A's loss increases by $1 (but does not exceed $5) for each marble that Player A's guess is "off" in excess of 5 marbles. In other words, as long as Player A's guess is within 5 marbles of the actual number of marbles in the container, Player A will incur no loss regardless of the Protection Level chosen by Player B. If Player A's guess is "off" by more than 5, however, Player A might lose up to $5, as shown in the table below (also provided in hard copy):

Absolute difference between Player A's guess and the actual number of marbles in the container	Amount of Player A's Loss
≤ 5	$0
6	$1
7	$2
8	$3
9	$4
≥ 10	$5

Keep in mind that as long as Player A's guess is within 5 marbles of the actual number of marbles in the container, the ***likelihood*** that Player A incurs a Loss (determined by the protection level chosen by Player B) does not really matter because the amount of the possible Loss for Player A will be $0.

If Player A guesses 60 and the actual number of marbles in the container is 40, what is the ***amount*** of Player A's Loss? $

If Player A guesses 35, the actual number of marbles in the container is 30, what is the ***amount*** of Player A's Loss? $

If Player A guesses 58, the actual number of marbles in the container is 50, what is the ***amount*** of Player A's Loss? $

--

Summary of Payments to Player A and Player B

[Again, the order in which the instructions present Player A's payment scheme is counter-balanced to match experimental sessions where Player A is incentivized to exhibit bias in the first set of five rounds and is incentivized to be unbiased in the second set of five rounds]

Player A's Payment <u>in the first set of five rounds</u> =

Fixed Pay of $5

plus Additional payment between $0 and $15. The amount of additional payment increases as the **actual number** of marbles in the container increases.

minus Player A's Loss (between $0 and $5), if applicable.

Player A's Payment <u>in the second set of five rounds</u> =

Fixed Pay of $5

plus Additional payment between $0 and $15. The amount of additional payment increases as **Player A's guess** increases.

minus Player A's Loss (between $0 and $5), if applicable.

Player B’s Payment =

Fixed Pay $20

minus the cost associated with the chosen Protection Level (between $0 and $5)

.

minus Player B’s Loss (between $0 and $15), if applicable.

More information on the random process that will be used to determine whether or not each player’s Loss applies will be given later.

--

Recap

[Again, the order in which the instructions present Player A’s payment scheme will be counter-balanced to match experimental sessions where Player A is incentivized to exhibit bias in the first set of five rounds and is incentivized to be unbiased in the second set of five rounds]

To summarize, Player A views a measurement from an imprecise scale and then makes a guess about the number of marbles in the container. The **measurement** provided by the scale can be anything between the *actual number of marbles in the container* minus 15 and the *actual number of marbles* plus 15. Player A can **guess** anything between the *measurement* minus 15 and the *measurement* plus 15.

<u>In the first set of five rounds</u>, Player A receives more additional payment when more marbles are **actually** in the container.

<u>In the second set of five rounds</u>, Player A can increase his or her additional payment by **guessing** a higher number of marbles.

While the measurement provided by the scale can be “off” by as much as 15 marbles in either direction, guesses that are closer to the measurement tend to be closer to the actual number of marbles, *on average.*

How far “off” Player A’s guess is from the actual number of marbles in the container determines the ***amount*** of a Loss that could apply to Player B (“Player B’s Loss”). The amount of Player B’s Loss ranges from $0 to $15.

Player B chooses a Protection Level that determines the ***likelihood*** that Player B incurs Player B’s Loss. Higher levels of protection are more costly to Player B.

Higher levels of protection also mean that Player A has a higher likelihood of incurring a separate Loss (“Player A’s Loss”) that ranges between $0 and $5 based on whether Player A’s guess is within 5 marbles of the actual number of marbles in the container.

--

Procedure
Depending on the number of participants in this session, it's possible that more than one Player B will be paired with a single Player A. From your perspective, this will not have any impact on how the experimental task proceeds. In fact, you won't even know if this occurs. If multiple Player Bs are paired with a single Player A, the computer program will randomly select one of the Player Bs and use his or her chosen Protection Levels when determining that particular Player A's final payment.

As mentioned earlier, each pairing will repeat the described tasks for 5 rounds. However, you won't find out the actual number of marbles in the container or whether you incur a Loss within each round until the end of the experiment. Again, each individual round is independent of the other rounds, meaning that potential gains and losses do not carry over from round to round.

Once you have finished the first set of 5 rounds, you will be anonymously paired with a different person in the session for another 5 rounds. However, you will remain assigned to the same role (Player A or Player B) for both sets of five rounds. As described previously, the manner in which Player A is compensated will change during the second set of five rounds.

In total, you will complete 10 rounds. The outcomes from **one** randomly selected round from the first set of 5 rounds and **one** randomly selected round from the second set of 5 rounds will determine your payoff for the experiment.

The selection of the rounds that will determine your payoff, as well as whether or not you will actually incur a Loss for each of those rounds, will be determined using random processes that will be explained later. The experimenter will assist you with these processes at the appropriate time.

--

Before continuing, please answer the following questions to ensure that you understand the task:

In pairs, you will complete five rounds of the experimental task, then switch to a new anonymous partner and complete another five rounds, although your role as Player A or Player B will not change. ○ true ○ false

Player A does not know the actual number of marbles in the container and must guess based on a measurement provided by an imprecise scale. The measurement provided by the scale can be anything between the actual number of marbles in the container *minus* 15 and the actual number of marbles in the container *plus* 15. ○ true ○ false

Player A can guess any number between the measurement provided by the scale minus 15 and the measurement plus 15. ○ true ○ false

For making the guess, Player A receives fixed pay of $5 and an additional payment. In the first set of five rounds, Player A's additional pay increases with the actual number of marbles in the container. In the second set of five rounds, Player A's additional pay increases with Player A's guess. ○ true ○ false

Loosely speaking, the ***amount*** of a Loss that might or might not apply to Player B increases as the number of marbles by which Player A's guess is "off" increases. ○ true ○ false

Player B chooses a Protection Level between 1 and 10. Higher levels of Protection *decrease* the ***likelihood*** that Player B incurs Player B's Loss. Higher Protection levels also mean that Player A has a *higher* ***likelihood*** of losing up to $5 if Player A's guess is "off" by more than 5. ○ true ○ false

Player B must pay more for higher levels of Protection than for lower levels of Protection. ○ true ○ false

--

Final Reminder

[Player A is incentivized to be unbiased in the first set of five rounds]

You have been assigned to the role of **Player A**.

Your job each round is to guess the number of marbles in a container based on a measurement provided by an imprecise scale.

During this first set of five rounds, you will be paid $5.00 for making the guess.

Irrespective of the number of marbles you guess, you will receive an additional payment between $0 and $15 based on the *actual number of marbles* in the container. The more marbles that are in the container, the higher your additional payment will be. The additional payment depends only on the actual number of marbles in the container, not how many marbles you *guess* are in the container.

You might lose up to $5 if the absolute value of the difference between your guess and the actual number of marbles in the container is greater than 5. The *likelihood* that you incur this Loss depends on the Protection Level chosen by Player B.

[Player A is incentivized to exhibit bias in the first set of five rounds]

You have been assigned to the role of **Player A**.

Your job each round is to guess the number of marbles in a container based on a measurement provided by an imprecise scale.

During this first set of five rounds, you will be paid $5.00 for making the guess.

Irrespective of the actual number of marbles in the container, you will receive an additional payment between $0 and $15 based on the number of marbles you guess. The more marbles that you guess, the higher your additional payment will be. The additional payment depends only on the number of marbles you guess are in the container, not the *actual* number of marbles in the container.

You might lose up to $5 if the absolute value of the difference between your guess and the actual number of marbles in the container is greater than 5. The *likelihood* that you incur this Loss depends on the Protection Level chosen by Player B.

[Player B]
You have been assigned to the role of **Player B**.

Player A's job is to guess the number of marbles in a container based on a measurement provided by an imprecise scale. As the number of marbles by which Player A's guess is "off" increases, the amount of your potential Loss increases (up to a maximum Loss of $15).

[Player B paired with unbiased Player A for the first set of five rounds]
For this first set of five rounds, in addition to a fixed payment, Player A receives an additional payment that increases as the *actual* number of marbles in the container increases. Unlike in later rounds, Player A cannot increase his or her additional payment by making a higher guess.

[Player B paired with biased Player A for the first set of five rounds]
For this first set of five rounds, in addition to a fixed payment, Player A increases his or her additional payment by guessing a higher number of marbles. Unlike in later rounds, this additional payment to Player A is not influenced by the actual number of marbles in the container.

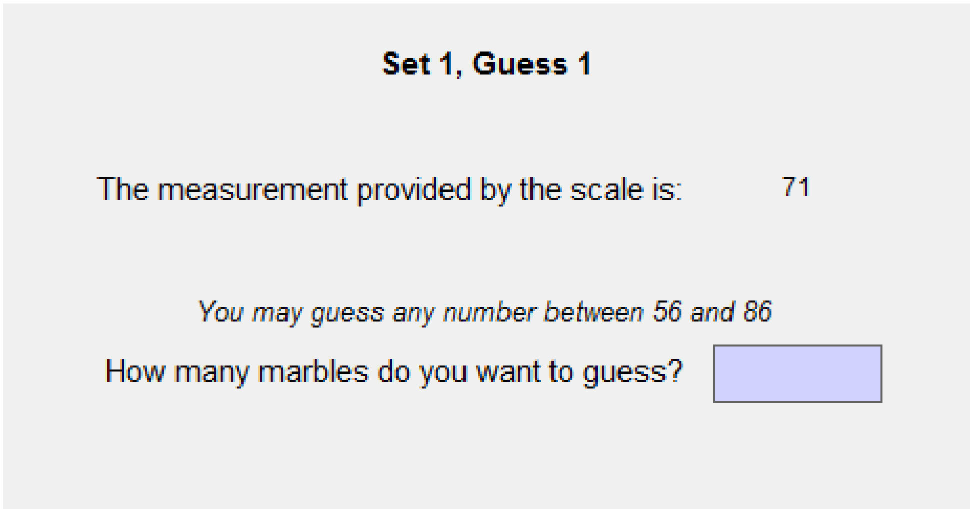
[All Player Bs]
You will start with $20 and, after viewing Player A's guess, will choose a Protection Level between 1 and 10. Protection Level 1 will cost you $0.50 and you must pay an additional $0.50 for each additional level of Protection.

The higher the Protection Level, the lower the chance that you will incur the Loss (up to $15) determined by the absolute difference between Player A's guess and the actual number of marbles in the container.

Higher levels of Protection also increase Player A's chance of losing up to $5 if the absolute value of the difference between Player A's guess and the actual number of marbles in the container is greater than 5.
--

PLAYER A’s ESTIMATE

[The below is an example of the screen at which Player A enters his/her estimate for each of the 10 experimental rounds (2 sets of 5 rounds)]



<u>PLAYER B's RISK ASSESSMENT (AND PRIMARY MANIPULATION OF EMPHASIS)</u>

[The following contains wording that (along with the first screen at the beginning of the instructions) is part of the between-participants manipulation of Bias Emphasis versus Dual Emphasis. The screens below are presented to Player B at the beginning of each five-round period. Again, references to Player A's compensation scheme (manipulated within-participants) are counterbalanced.]

[Bias Emphasis]

In this <u>first set of five rounds</u> the additional payment to Player A increases as the actual number of marbles in the container increases.

Player A's Incentives

Because Player A's guess does not impact Player A's additional payment, but Player A's Loss is based on the number of marbles by which his or her guess is "off", Player A's incentives are best served when he or she guesses a number that is close to the measurement provided by the scale.

How concerned are you about the possibility that you will incur the Loss of up to $15 and, as a result, get a low payment for this set of five rounds?

--

[PLAYER B's SELECTION OF COSTLY EFFORT and SCREENS DISPLAYED AFTER COMPLETION OF FIRST SET OF FIVE ROUNDS, shown below, appear here]

--

In this <u>second set of five rounds</u> the additional payment to Player A increases as the number of marbles Player A guesses increases.

Player A's Incentives

Because Player A can get a higher payment by guessing more marbles (and the amount of this additional payment is more than Player A's possible Loss), Player A has an incentive to always guess more marbles than indicated by the measurement provided by the scale.

How concerned are you about the possibility that you will incur the Loss of up to $15 and, as a result, get a low payment for this set of five rounds?

[Dual Emphasis]
In this first set of five rounds the additional payment to Player A increases as the actual number of marbles in the container increases.

Player A’s Incentives
Because Player A’s guess does not impact Player A’s additional payment, but Player A’s Loss is based on the number of marbles by which his or her guess is “off”, Player A’s incentives are best served when he or she guesses a number that is close to the measurement provided by the scale.

Imprecision of the Scale
The fact that the scale used to weigh the marbles is imprecise contributes to the possibility that the measurement viewed by Player A, and ultimately his or her guess, might not be very close to the actual number of marbles in the container.

How concerned are you about the possibility that you will incur the Loss of up to $15 and, as a result, get a low payment for this set of five rounds?

Not at all concerned ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Very concerned

--
[PLAYER B’s SELECTION OF COSTLY EFFORT and SCREENS DISPLAYED AFTER COMPLETION OF FIRST SET OF FIVE ROUNDS, shown below, appear here]
--
In this second set of five rounds the additional payment to Player A increases as the number of marbles Player A guesses increases.

Player A’s Incentives
Because Player A can get a higher payment by guessing more marbles (and the amount of this additional payment is more than Player A’s possible Loss), Player A has an incentive to always guess more marbles than indicated by the measurement provided by the scale.

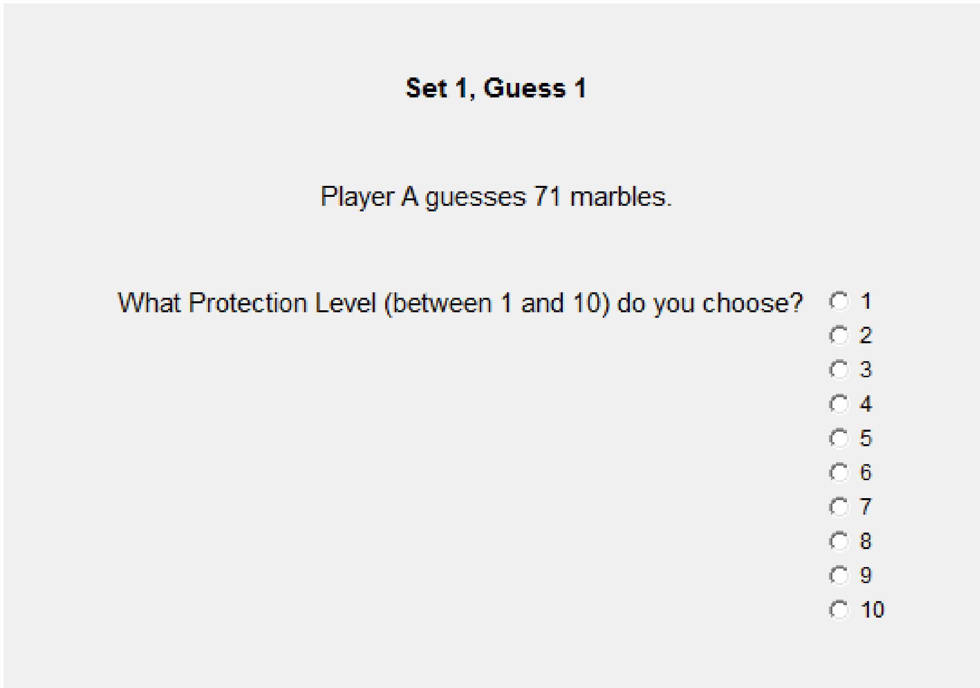
Imprecision of the Scale
The fact that the scale used to weigh the marbles is imprecise contributes to the possibility that the measurement viewed by Player A, and ultimately his or her guess, might not be very close to the actual number of marbles in the container.

How concerned are you about the possibility that you will incur the Loss of up to $15 and, as a result, get a low payment for this set of five rounds?

Not at all concerned ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Very concerned

PLAYER B's SELECTION OF COSTLY AUDIT EFFORT

[The below is an example of the screen at which Player B views Player A's estimate and selects a level of costly audit effort for each of the 10 experimental rounds (2 sets of 5 rounds)]



Set 1, Guess 1

Player A guesses 71 marbles.

What Protection Level (between 1 and 10) do you choose?

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10

SCREENS DISPLAYED AFTER COMPLETION OF FIRST SET OF FIVE ROUNDS

[After the first five rounds participants are shuffled into new anonymous pairings and Player A's compensation scheme changes. To reiterate, "risk of management bias" is a (counterbalanced) within-participants manipulation. These screens are meant to remind participants of the change in Player A's compensation scheme. For Player B, the relevant screen below appears prior to the Risk Assessment screen shown above for the second set of five rounds.]

[Player A was incentivized to be unbiased in the first set of five rounds]

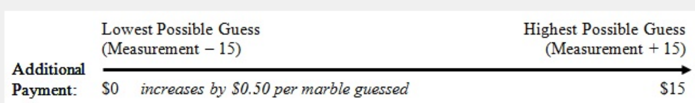
You have just completed the first set of five rounds.

For this second set of five rounds, you will be randomly paired with a **different** person who is in the role of Player B.

Also remember that for the next five rounds you will be compensated in a manner that is **different** from the way you were paid in the first five rounds.

Now the additional payment that you receive does not depend on the actual number of marbles in the container**. Instead, during the next five rounds, your additional payment will increase as the number of marbles that you guess increases.**

To review, beyond the fixed payment of $5.00, if your guess is equal to the measurement provided by the scale minus 15 (the lowest possible guess you can make), your additional payment will be $0. For each marble you guess above this lowest possible guess, you will receive an additional $0.50. This is illustrated by the following diagram:



Like before, you might also incur a Loss of up to $5 if the absolute difference between your guess and the actual number of marbles in the container is greater than 5.

True or false:

For the next five rounds, the amount of your additional payment depends on the number of marbles you guess. ○ true ○ false

For the next five rounds, the amount of your additional payment depends on the actual number of marbles in the container. ○ true ○ false

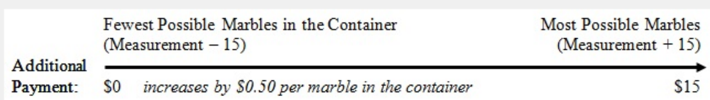
[Player A was incentivized to be biased in the first set of five rounds]
You have just completed five rounds.

For this second set of five rounds, you will be randomly paired with a **different** person who is in the role of Player B.

Also remember that for the next five rounds you will be compensated in a manner that is **different** from the way you were paid in the first five rounds.

Now the additional payment that you receive does not depend on the number of marbles that you guess. **Instead, during the next five rounds, your additional payment will be based on the actual number of marbles in the container.**

To review, beyond the fixed payment of $5.00, if the actual number of marbles in the container is equal to the measurement minus 15 (the lowest possible number of marbles in the container given the measurement observed), Player A's additional payment will be $0. For each marble above this amount, Player A will receive an additional $0.50. This is illustrated by the following diagram:



Like before, you might also incur a Loss of up to $5 if the absolute difference between your guess and the actual number of marbles in the container is greater than 5.

True or false:

For the next five rounds, the amount of your additional payment depends on the number of marbles you guess. ◯ true ◯ false

For the next five rounds, the amount of your additional payment depends on the actual number of marbles in the container. ◯ true ◯ false

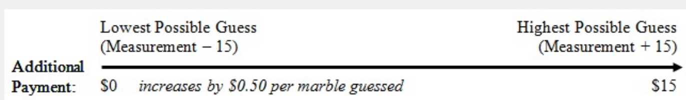
[Player B was paired with an unbiased Player A in the first set of five rounds]
You have just completed five rounds.

For this second set of five rounds, you will be randomly paired with a **different** person who is in the role of Player A.

Also remember that this new Player A for the next five rounds is compensated in a manner that is **different** from the way Player A was paid in the first five rounds.

Now the additional payment that Player A receives does not depend on the actual number of marbles in the container**. Instead, during the next five rounds, Player A's additional payment will increase as the number of marbles that Player A guesses increases.**

To review, beyond the fixed payment of $5.00, if Player A's guess is equal to the measurement provided by the scale minus 15 (the lowest possible guess Player A can make), Player A's additional payment will be $0. For each marble Player A guesses above this lowest possible guess, Player A will receive an additional $0.50. This is illustrated by the following diagram:



Like before, Player A might also incur a Loss of up to $5 if the absolute difference between Player A's guess and the actual number of marbles in the container is greater than 5.

True or false:

For the next five rounds, the amount of the additional payment to Player A depends on the number of marbles guessed by Player A. ○ true ○ false

For the next five rounds, the amount of the additional payment to Player A depends on the actual number of marbles in the container. ○ true ○ false

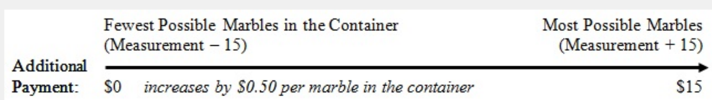
[Player B was paired with a biased Player A in the first set of five rounds]
You have just completed five rounds.

For this second set of five rounds, you will be randomly paired with a **<u>different</u>** person who is in the role of Player A.

Also remember that this new Player A for the next five rounds is compensated in a manner that is **<u>different</u>** from the way Player A was paid in the first five rounds.

Now the additional payment that Player A receives does not depend on the number of marbles that Player A guesses. **Instead, during the next five rounds, Player A's additional payment will be based on the actual number of marbles in the container.**

To review, beyond the fixed payment of $5.00, if the actual number of marbles in the container is equal to the measurement minus 15 (the lowest possible number of marbles in the container given the measurement observed), Player A's additional payment will be $0. For each marble above this amount, Player A will receive an additional $0.50. This is illustrated by the following diagram:



Like before, Player A might also incur a Loss of up to $5 if the absolute difference between Player A's guess and the actual number of marbles in the container is greater than 5.

True or false:

For the next five rounds, the amount of the additional payment to Player A depends on the number of marbles guessed by Player A. ○ true ○ false

For the next five rounds, the amount of the additional payment to Player A depends on the actual number of marbles in the container. ○ true ○ false

--

PROMPT FOR POST-EXPERIMENTAL QUESTIONNAIRE

You have just completed both sets of five rounds. Next, you will answer some questions that are intended to provide some insight into the decisions that you made today.

After you answer these questions, the experimenter will assist you with processes that randomly determine which rounds will count toward your payoff and whether you will incur a penalty related to those rounds.

At this time, please raise your hand and the experimenter will provide you with the questionnaire.

Once you have completed the questionnaire, you will be instructed to raise your hand again and the experimenter will assist you with determining your payment. **Do NOT press the "OK" button below until instructed to do so.**

PLAYER A's POST-EXPERIMENTAL QUESTIONNAIRE

[PEQ distributed and completed in hard copy]

Please answer the following questions.

You just completed two sets of five rounds. In each set of five rounds you received different payments for guessing the number of marbles.

How were you compensated in the **first** set of five rounds?

a. Fixed pay of $5.00, with an additional payment that increased as the actual number of marbles in the container increased.

b. Fixed pay of $5.00, with an additional payment that increased as the number of marbles you guessed increased.

How were you compensated in the **second** set of five rounds?

a. Fixed pay of $5.00, with an additional payment that increased as the actual number of marbles in the container increased.

b. Fixed pay of $5.00, with an additional payment that increased as the number of marbles you guessed increased.

To what extent do you agree or disagree with the following statements?

When guessing the number of marbles, I always guessed exactly the number of marbles that I thought were in the container.

During the first set of five rounds:

Strongly disagree			Neither agree nor disagree			Strongly agree
1	2	3	4	5	6	7

During the second set of five rounds:

Strongly disagree			Neither agree nor disagree			Strongly agree
1	2	3	4	5	6	7

When guessing the number of marbles, I thought it was best to just always guess a number equal to the measurement provide by the scale.
During the first set of five rounds:

Strongly disagree			Neither agree nor disagree			Strongly agree
1	2	3	4	5	6	7

During the second set of five rounds:

Strongly disagree			Neither agree nor disagree			Strongly agree
1	2	3	4	5	6	7

I thought that the further my guess was from the measurement provided by the scale, the more likely it was that Player B's Loss would be higher and I might lose up to $5.

Strongly disagree			Neither agree nor disagree			Strongly agree
1	2	3	4	5	6	7

I was concerned about the possibility that my guess would have negative consequences for Player B.
During the first set of five rounds:

Strongly disagree			Neither agree nor disagree			Strongly agree
1	2	3	4	5	6	7

During the second set of five rounds:

Strongly disagree			Neither agree nor disagree			Strongly agree
1	2	3	4	5	6	7

I wanted to maximize my payoff, regardless of what it meant for Player B.

Strongly disagree			Neither agree nor disagree			Strongly agree
1	2	3	4	5	6	7

I thought Player B was likely to choose a Protection Level that would minimize Player B's chance of incurring a Loss, regardless of what it meant for me.
During the first set of five rounds:

Strongly disagree			Neither agree nor disagree			Strongly agree
1	2	3	4	5	6	7

During the second set of five rounds:

Strongly disagree			Neither agree nor disagree			Strongly agree
1	2	3	4	5	6	7

I put a high amount of effort into understanding the instructions and carefully thinking about my decisions.

Strongly disagree			Neither agree nor disagree			Strongly agree
1	2	3	4	5	6	7

I enjoyed participating in this activity and found it interesting.

Strongly disagree			Neither agree nor disagree			Strongly agree
1	2	3	4	5	6	7

On average, what Protection Level (1 to 10) do you think Player B chose during the first set of five rounds?

_____

On average, what Protection Level (1 to 10) do you think Player B chose during the second set of five rounds?

_____

How willing are you to take risks, in general?

Not at all willing			Neither willing nor unwilling			Very willing
1	2	3	4	5	6	7

Please indicate on the scale below which is most important to you:

Avoiding Negative Outcomes			Both are equally important			Getting positive outcomes
1	2	3	4	5	6	7

To what extent do you agree or disagree with the following statement: All else equal, I tend to avoid situations where the outcome is uncertain.

Strongly disagree			Neither agree nor disagree			Strongly agree
1	2	3	4	5	6	7

Hypothetically, how much would you be willing to pay for a lottery ticket that gives you a 50% chance of winning $100 (and a 50% chance of winning nothing)?

$__________

Assume that you have up to $10,000 to invest in a stock that has a 50% chance of doubling your investment and a 50% chance of returning only half of your investment. How much (any amount between $0 and $10,000) would you be willing to invest in such a stock?

$__________

A few more questions to help us understand the decisions you made today…

Imagine that we rolled a fair, six-sided die 1,000 times. Out of 1,000 rolls, how many times do you think the die would come up even (that is, come up showing 2, 4, or 6)?

______

In the BIG BUCKS LOTTERY, the chances of winning a $10.00 prize is 1%. What is your best guess about how many people would win a $10.00 prize if 1,000 people each buy a single ticket to BIG BUCKS?

______

In the ACME PUBLISHING SWEEPSTAKES, the chance of winning a car is 1 in 1,000. What percent of tickets to ACME PUBLISHING SWEEPSTAKES win a car?

______

What is your gender (circle one)?

Male Female

What is your major? __________________

What is your class level (i.e., Freshman, Sophomore, Junior, or Senior)? _____________

What is your age? _____

Thank you for taking the time to complete this questionnaire! Now that you have finished, please <u>raise your hand</u> for the experimenter to come and assist you with the final steps necessary to determine your payment.

PLAYER B's POST-EXPERIMENTAL QUESTIONNAIRE

[PEQ distributed and completed in hard copy]

Please answer the following questions.

You just completed two sets of five rounds. In each set of five rounds you were paired with a participant in the Player A role who received different payments for guessing the number of marbles.

How was Player A compensated in the **first** set of five rounds?

c. Fixed pay of $5.00, with an additional payment that increased as the actual number of marbles in the container increased.

d. Fixed pay of $5.00, with an additional payment that increased as the number of marbles Player A guessed increased.

How was Player A compensated in the **second** set of five rounds?

a. Fixed pay of $5.00, with an additional payment that increased as the actual number of marbles in the container increased.

b. Fixed pay of $5.00, with an additional payment that increased as the number of marbles Player A guessed increased.

In general, how much emphasis did the experimental materials place on the fact that Player A's guess contributed to the amount of your potential loss?

Not emphasized						Heavily emphasized
1	2	3	4	5	6	7

In general, how much emphasis did the experimental materials place on the fact that the imprecision of the scale contributed to the amount of your potential loss?

Not emphasized						Heavily emphasized
1	2	3	4	5	6	7

True or False: The measurement provided by the scale could be "off" by up to 15 marbles in either direction.

a. True

b. False

To what extent do you agree or disagree with the following statements?

I thought the amount of the Loss I might incur was likely to be larger when Player A's additional payment increased as the number of marbles Player A guessed increased.

Strongly disagree			Neither agree nor disagree			Strongly agree
1	2	3	4	5	6	7

The way Player A was compensated had a big impact on the Protection Level I chose.

Strongly disagree			Neither agree nor disagree			Strongly agree
1	2	3	4	5	6	7

The fact that the scale Player A used to estimate the number of marbles in the container was not very precise had a big impact on the Protection Level I chose.

Strongly disagree			Neither agree nor disagree			Strongly agree
1	2	3	4	5	6	7

I was concerned about the possibility that the Protection Level I chose would have negative consequences for Player A.
During the first set of five rounds:

Strongly disagree			Neither agree nor disagree			Strongly agree
1	2	3	4	5	6	7

During the second set of five rounds:

Strongly disagree			Neither agree nor disagree			Strongly agree
1	2	3	4	5	6	7

I wanted to maximize my payment, regardless of what it meant for Player A.
During the first set of five rounds:

Strongly disagree			Neither agree nor disagree			Strongly agree
1	2	3	4	5	6	7

During the second set of five rounds:

Strongly disagree			Neither agree nor disagree			Strongly agree
1	2	3	4	5	6	7

I put a high amount of effort into understanding the instructions and carefully thinking about my decisions.

Strongly disagree			Neither agree nor disagree			Strongly agree
1	2	3	4	5	6	7

I enjoyed participating in this activity and found it interesting.

Strongly disagree			Neither agree nor disagree			Strongly agree
1	2	3	4	5	6	7

Assume that Player A saw the following measurement from the scale used to weigh the container full of marbles: **50**

If Player A's additional payments were based on the actual number of marbles in the container, how many marbles, on average, do you think Player A would guess?

_____

If Player A's additional payments increased as the number of marbles Player A guessed increased, how many marbles, on average, do you think Player A would guess?

_____

How willing are you to take risks, in general?

Not at all willing			Neither willing nor unwilling			Very willing
1	2	3	4	5	6	7

Please indicate on the scale below which is most important to you:

Avoiding Negative Outcomes			Both are equally important			Getting positive outcomes
1	2	3	4	5	6	7

To what extent do you agree or disagree with the following statement: All else equal, I tend to avoid situations where the outcome is uncertain.

Strongly disagree			Neither agree nor disagree			Strongly agree
1	2	3	4	5	6	7

Hypothetically, how much would you be willing to pay for a lottery ticket that gives you a 50% chance of winning $100 (and a 50% chance of winning nothing)?

$_________

Assume that you have up to $10,000 to invest in a stock that has a 50% chance of doubling your investment and a 50% chance of returning only half of your investment. How much (any amount between $0 and $10,000) would you be willing to invest in such a stock?

$_________

A few more questions to help us understand the decisions you made today…

Imagine that we rolled a fair, six-sided die 1,000 times. Out of 1,000 rolls, how many times do you think the die would come up even (that is, come up showing 2, 4, or 6)?

______

In the BIG BUCKS LOTTERY, the chances of winning a $10.00 prize is 1%. What is your best guess about how many people would win a $10.00 prize if 1,000 people each buy a single ticket to BIG BUCKS?

______

In the ACME PUBLISHING SWEEPSTAKES, the chance of winning a car is 1 in 1,000. What percent of tickets to ACME PUBLISHING SWEEPSTAKES win a car?

______

What is your gender (circle one)?

Male Female

What is your major? __________________

What is your class level (i.e., Freshman, Sophomore, Junior, or Senior)? _____________

What is your age? _____

Statements that people use to describe themselves are given below. Please circle the response that indicates how you generally feel. There are no right or wrong answers. Do not spend too much time on any one statement.

	Strongly Disagree					Strongly Agree
I often accept other people's explanations without further thought.	1	2	3	4	5	6
I feel good about myself.	1	2	3	4	5	6
I wait to decide on issues until I can get more information.	1	2	3	4	5	6
The prospect of learning excites me.	1	2	3	4	5	6
I am interested in what causes people to behave the way that they do.	1	2	3	4	5	6
I am confident of my abilities.	1	2	3	4	5	6
I often reject statements unless I have proof that they are true.	1	2	3	4	5	6
Discovering new information is fun.	1	2	3	4	5	6
I take my time when making decisions.	1	2	3	4	5	6
I tend to immediately accept what other people tell me.	1	2	3	4	5	6
Other people's behavior does not interest me.	1	2	3	4	5	6
I am self-assured.	1	2	3	4	5	6
My friends tell me that I usually question things that I see or hear.	1	2	3	4	5	6

	Strongly Disagree					Strongly Agree
I like to understand the reason for other people's behavior.	1	2	3	4	5	6
I think that learning is exciting.	1	2	3	4	5	6
I usually accept things I see, read, or hear at face value.	1	2	3	4	5	6
I do not feel sure of myself.	1	2	3	4	5	6
I usually notice inconsistencies in explanations.	1	2	3	4	5	6
Most often I agree with what the others in my group think.	1	2	3	4	5	6
I dislike having to make decisions quickly.	1	2	3	4	5	6
I have confidence in myself.	1	2	3	4	5	6
I do not like to decide until I've looked at all of the readily available information.	1	2	3	4	5	6
I like searching for knowledge.	1	2	3	4	5	6
I frequently question things that I see or hear.	1	2	3	4	5	6
It is easy for other people to convince me.	1	2	3	4	5	6
I seldom consider why people behave in a certain way.	1	2	3	4	5	6
I like to ensure that I've considered most available information before making a decision.	1	2	3	4	5	6

	Strongly Disagree					Strongly Agree
I enjoy trying to determine if what I read or hear is true.	1	2	3	4	5	6
I relish learning.	1	2	3	4	5	6
The actions people take and the reasons for those actions are fascinating.	1	2	3	4	5	6

Thank you for taking the time to complete this questionnaire! Now that you have finished, please <u>raise your hand</u> for the experimenter to come and assist you with the final steps necessary to determine your payment.

DETERMINATION OF PROBABILISTIC OUTCOMES

[At this point, the experimenter assisted each individual participant with determining probabilistic outcomes, as described below, and entering the appropriate input.]

To determine which two rounds will count towards your payment, you will draw a card from a deck of five cards numbered from 1 to 5. This will be done twice, the first draw will determine the round from the first set of five rounds that will count towards your payment, and the second draw will determine the round from the second set that will count.

Which round from the first set of five will count towards your payment?

Which round from the second set of five will count towards you payment?

Based on the Protection Level chosen by Player B in the each of the selected rounds, you have a specific percentage chance of incurring a Loss of a certain amount based on how far "off" your guess is from the actual number of marbles in the bag.

To determine whether this Loss will apply, you will draw a single card from a deck with 100 cards numbered from 1 to 100. If the number on the card drawn is equal to or less than the percent corresponding to the Protection Level chosen by Player B, you will incur the Loss. Otherwise, the Loss will not apply.

Card drawn to determine whether Loss applies for the first round selected.

Card drawn to determine whether Loss applies for the second round selected.

EXAMPLE PAYOFF SCREEN FOR PLAYER A

Your payment is calculated as follows:

"Show up" payment $	5.00
Results from First Set	
Round Selected:	5
Actual number of marbles in the container:	40
Measurement provided by the scale:	43
Number of marbles you guessed:	58
Fixed Pay for making a guess: $	5.00
Additional pay based on *actual number of marbles in the container*: $	6.00
Amount of possible Loss *(if your guess is "off" by more than 10)* $	5.00
Protection Level selected by Player B	10
% likelihood of loss associated with selected Protection Level:	95
Card drawn to determine whether Loss will apply *(loss will apply is card drawn is lower than stated probability)*	68
Does the Loss apply?	YES
Total pay from first set: $	6.00
Results from Second Set	
Round Selected:	4
Actual number of marbles in the container:	59
Measurement provided by the scale:	68
Number of marbles you guessed:	68
Fixed Pay for making a guess: $	5.00
Additional pay based on *the number of marbles you guessed*: $	7.50
Amount of possible Loss *(if your guess is "off" by more than 10)* $	0.00
Protection Level selected by Player B:	5
% likelihood of loss associated with selected Protection Level:	35
Card drawn to determine whether Loss will apply *(loss will apply is card drawn is lower than stated probability)*	14
Does the Loss apply?	YES
Total pay from second set: $	12.50
Your total payment for participating today *("Show up" fee + Pay from First Set + Pay from Second Set)* **$**	23.50

EXAMPLE PAYOFF SCREEN FOR PLAYER B

Your payment is calculated as follows:

"Show up" payment $	5.00
Results from First Set	
Round Selected:	2
Actual number of marbles in the container:	38
Measurement provided by the scale:	49
Number of marbles guessed by Player A:	64
Your Fixed Pay: $	20.00
Amount of possible Loss *(based on how far Player A's guess is "off" from the actual number of marbles in the container):* $	15.00
Protection Level you selected:	10
The cost associated with the protection Level you selected: $	5.00
% likelihood of loss associated with selected Protection Level:	5
Card drawn to determine whether Loss will apply *(loss will apply is card drawn is lower than stated probability)*	51
Does the Loss apply?	NO
Total pay from first set: $	15.00
Results from Second Set	
Round Selected:	3
Actual number of marbles in the container:	55
Measurement provided by the scale:	49
Number of guessed by Player A:	49
Your Fixed Pay: $	20.00
Amount of possible Loss *(based on how far Player A's guess is "off" from the actual number of marbles in the container):* $	6.00
Protection Level you selected:	5
The cost associated with the protection Level you selected: $	2.50
% likelihood of loss associated with selected Protection Level:	45
Card drawn to determine whether Loss will apply *(loss will apply is card drawn is lower than stated probability)*	25
Does the Loss apply?	YES
Total pay from second set: $	11.50
Your total payment for participating today *("Show up" fee + Pay from First Set + Pay from Second Set)* **$**	31.50

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